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Higher Education for High Technology

Saving Nuclear Power

TechnologyReview

Edited at the Massachusetts Institute of Technology

Acid Rain: Time to Move

technology
review
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Porsche 917 Turbo

Porsche 908

Porsche 911

Porsche 356

One Man's

Dr. Ferry Porsche

My work and my hobby are the same: building cars that are fun to drive. Building cars that have the best possible engineering. Building *Porsches*.

The very first Porsche was the 356.

We had no marketing research to guide us. So it was designed to my personal specifications: small, lightweight, with good handling, and the power of a large car.

The idea was to build a racing car for the normal roads. And, in fact, in 1951, when the 356 was first entered at Le Mans, it won its class.

The second Porsche was, *and still is*, the 911.

First produced in 1964, it's forever young. Its engine displacement has been increased from the original 2 liters to 3 liters. And its output has been raised from 130 hp to 172 hp. Today, on the track, the 911 accelerates from 0 to 50 mph in 5.8 seconds. Its maximum speed: 139 mph.

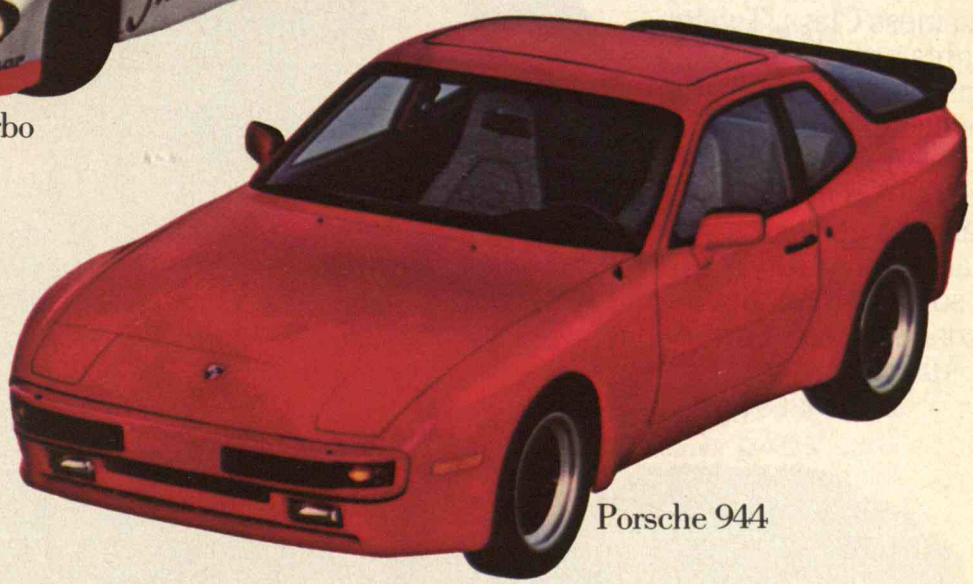
The 911 and its derivatives have won countless major victories in motor sport, including rallies, hill climbs, and races. The 935 Turbo, for example, won the World Championship of Makes in 1976, '77, '78, and '79.

At Porsche, we view the race track as a proving ground. For on the track, under the stresses, surprises, and realities of competition, the best engineering wins. And what we learn from our race cars, we put into our production cars.

Porsche 928

Porsche 935 Turbo

Porsche 936 Turbo



Porsche 944

Family.

The 917 Turbo Can-Am champion (1973) made turbocharging practical for production cars.

The 936 Turbo Le Mans champion (1976,'77,'81) further advanced engine design and aerodynamic efficiency.

The 908 Targa Florio champion (1970) set the handling standards for all Porsches, including our new-generation 928.

The 928 has a 4.5-liter, 220-hp, aluminum Porsche V-8 engine. On the track, it accelerates from 0 to 50 mph in 6.0 seconds. And it has a maximum speed of 143 mph.

The 928 also has the Porsche transaxle design which produces balanced braking and improved cornering. And the 928 offers unprecedented comfort and luxury in a Porsche.

The newest Porsche is the 944.

It has a new 2.5-liter, 143-hp, aluminum Porsche engine, built at Zuffenhausen. On the track, it accelerates from 0 to 50 mph in 5.9 seconds. And it has a maximum speed of 130 mph.

The 944 also has the Porsche transaxle design, Porsche handling, and Porsche aerodynamics.

To me, the 944 is more than a new car. It is a new and true Porsche.

At Porsche, excellence is expected.

Dr. F. Porsche
Stuttgart

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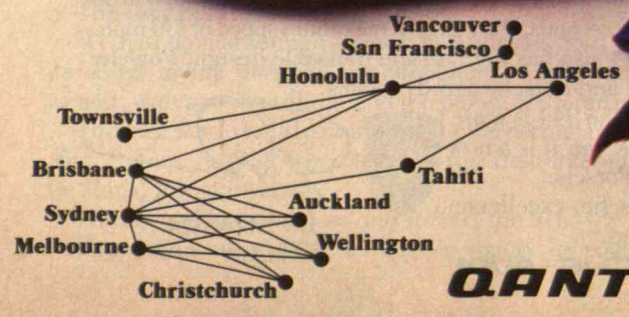

QANTAS The Australian Airline.

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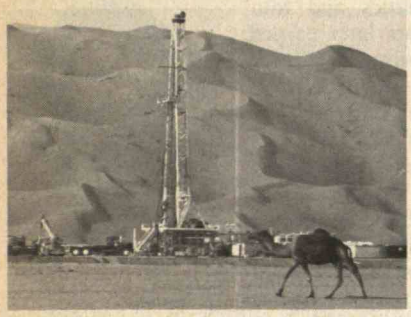
Technology Review



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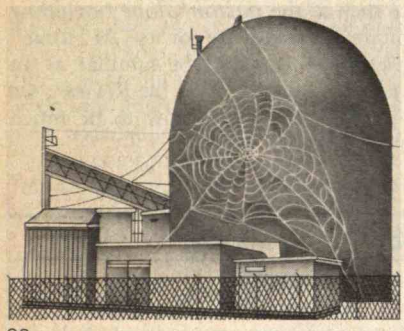

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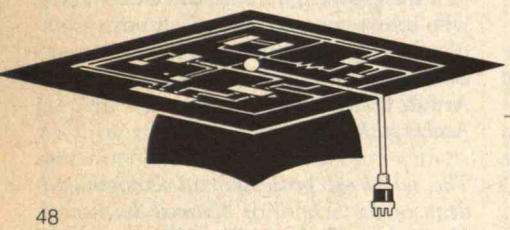

48

58

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FIRST LINE

Classicist at the Desk

The smallness of *Technology Review*'s staff is at once a frustration and an opportunity—a frustration since our size sometimes limits the size of the net we cast into the ever-broadening stream of technology and its implications, and an opportunity because each editor has such a large influence on the way that net is cast.

Given the editors' opportunity to affect the magazine's course and syle, readers will have a special reason to look forward to future issues. For Jonathan Schlefer, the new name on our masthead this month, brings to the *Review* an unusual range of experience and interests. He was graduated from Harvard in 1972 with highest honors in ancient Greek and mathematics and four years later earned a master's degree in architecture at the University of California at Berkeley. For most of the time since then he has been a free-lance writer in Boston—a regular contributor to *The Real Paper* before its demise in 1981 and since then to the *Boston Globe* (including a column on hardware for its "At Home" pages). His name may be familiar as an occasional contributor to the *Review*; we rejoice that his role is now to be much more substantial.—*J.M.*

J. Schlefer

LETTERS

Minting Costs for Research

Larry Penberthy (*May/June, page 84*) suggests saving $40 million by not minting any more pennies. On page 83, the American Astronautical Society says we need $40 million to support planetary research. Let's do it! This would also be good for public visibility regarding the positive benefits of science.
Rush Hood
Tampa, Fla.

Renouncing Chemical Weapons

The statement attributed to me in "Stirring the Chemical Arms Race" (*May/June, page 75*) that "there is very strong evidence that chemical agents (including 'Yellow Rain' mycotoxin) are being used" in Afghanistan and Southeast Asia was not mine, but rather was made by another panelist. To the contrary, I tried to make it clear that I had no direct basis for supporting or denying such an allegation, and that the administration had not been able to present convincing evidence to support such an allegation. I might add that the administration has not been able to strengthen its case in the last few months.

The possibility (or even reality) of such chemical warfare provides no justification—whether military, political, or legal—for the administration's activities in developing a new generation of chemical weapons. The United States should join the growing number of NATO allies who have renounced the use or possession of all chemical and biological weapons, even for deterrence or reprisal.
Arthur H. Westing
Amherst, Mass.

The writer is professor of ecology and dean of the School of Natural Science at Hampshire College. The Review *regrets the error in attribution.*

Energy Alternatives

John Tirman (*"Investing in the Energy Transition: From Oil to What?," April, page 64*) misses entirely one of the major developments in alternative energy financing: the tax-law changes enacted in 1981. These include the Accelerated Cost Recovery System and the repeal of the "at-risk" provision for alternative energy investments.

The result has been an explosion of private investor interest and activity in the renewable energy industry since late 1981. Investors have financed ventures ranging from micro-hydroelectric plants and wind farms to solar equipment leased to businesses and homes.

The United States doesn't need more "fiscal policy tools available to federal,

Risk Analysis in Congress Revisited: A Correction

Representative Don Ritter was quoted in these columns (*"Risk Analysis in Congress," July, page 3*) as advocating legislation that "mandates the use of risk evaluation as one of the many tools in regulating hazard." Mr. Ritter's bill (H.R. 6159, approved by the House of Representatives and sent to the Senate on August 2), seeks to encourage (but does *not* mandate) the use of risk evaluation techniques. It calls for a two-year research and demonstration program to improve risk analysis and comparison techniques in regulatory decision making. The *Review* regrets the error in publishing Mr. Ritter's original letter.—*Ed.*

state, and local governments" to encourage energy conservation. We need to get government out of all direct subsidies to "conventional" energy, including the continued billion-dollar annual commitment to the nuclear power industry. We need to stimulate the use of private investment capital to encourage energy conservation. Better a sensible incentive than a handout or mandate any day.
Jerry Yudelson
Pacheco, Calif.

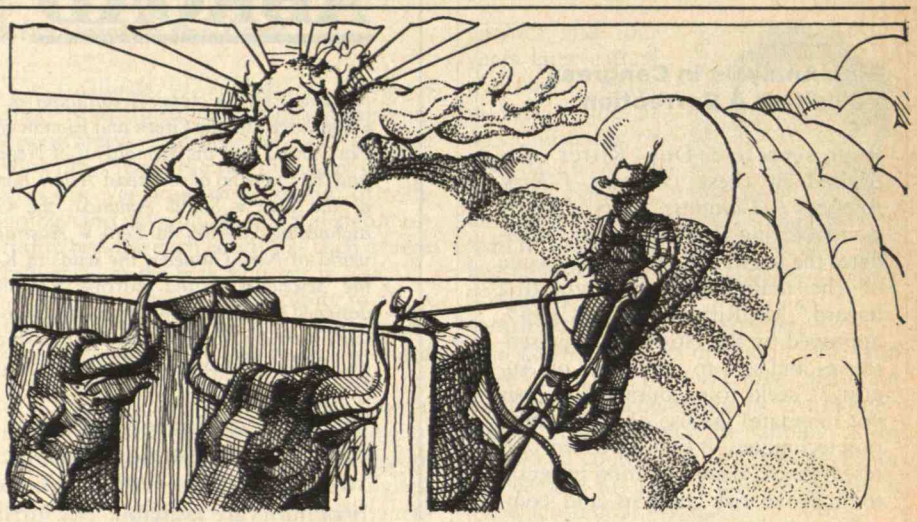
Mr. Tirman perpetuates the myth that federal involvement in commercial nuclear energy has been disproportionate and misdirected. Studies by the National Academy of Sciences, Ford Foundation, *Mercer Law Review*, and Resources for the Future indicate that coal and nuclear power are the only large-scale alternatives to oil and gas. Given this situation, it is appropriate that industry and the government invest in these energy sources.

The total federal subsidy for commercial nuclear energy has been about the same as that for hydro, coal, and natural gas, while the subsidy for oil is still many times that for any of these sources.
Frank A. Iddings
Baton Rouge, La.

The writer is professor of nuclear science at Louisiana State University.

ROBERT COWEN

Whither Weather Modification?



SOME 32 years ago, the late Irving Langmuir tried to convince a skeptical audience that he could influence the weather. My report on that National Academy of Sciences meeting says his paper was "presented with great vehemence" and "startled the assembled audience."

Four years earlier, his colleague at the General Electric Research Laboratories, Vincent Schaefer, had made meteorological history when he cut a hole in a deck of stratocumulus clouds by dropping 1.5 kilograms of dry ice. Now Langmuir was claiming that he could modulate large-scale weather patterns throughout the eastern United States by putting small amounts of silver-iodide crystals into New Mexico's air.

It made a great story that won me my first front-page byline—a sort of puberty rite in the newspaper business. But nobody was convinced. Langmuir had no hard evidence to back up his claim and his histrionics were soon forgotten. Three decades later—after many "promising" experiments and expressions of "cautious" optimism—weather modifiers still have no hard evidence that they can do much more than cut holes in stratus decks.

The Reagan administration, with a sharp knife for any possible budget cuts, wants to eliminate the National Oceanic and Atmospheric Administration's (NOAA) weather modification funds. Congress may not go that far. At this writing, legislation in the House would give NOAA $4 million for such research; the Senate was considering $5 million. But even if NOAA does get some money for weather modification, it will be clearly earmarked for basic research, not rainmaking field operations, according to a member of the Senate Commerce Committee staff. "It's time to get back to fundamentals—to try to gain better understanding of the physics of weather modification—and be a litle more modest in our claims," he adds.

This is no more than some prominent weather modification scientists have been saying. Roscoe R. Braham, Jr., of the University of Chicago, a pioneer in this field, outlined the situation three years ago at a meeting of the American Meteorological Society. "The field of weather modification is undergoing a change—one born of increasing dissatisfaction with heavy dependence on statistical analysis of ground-level precipitation, nurtured by increasing understanding of clouds and cloud systems." He added, "Our efforts would be more productive if we set aside the approach we have been using since 1960 and returned to experiments that place the highest priority on improving our basic understanding of clouds."

ROBERT C. COWEN is science editor of the *Christian Science Monitor* and former president of the National Association of Science Writers.

The Complexity of Clouds

The still rudimentary, but growing, understanding of clouds has revealed the complexity of the systems with which weather modifiers are working. Seeding aims to increase rainfall, suppress hail, or make hurricanes more gentle. Researchers do this by manipulating the microprocesses by which cloud drops and ice crystals form or changing the dynamics of cloud growth. Silver iodide may be used to encourage ice crystals to form, acting as nuclei for raindrops. The heat released when cloud drops freeze may also increase the buoyancy of cloud air and the vigor of cloud growth. Conversely, overseeding can inhibit crystals from forming. But there may be a dozen or more key stages between ice crystal formation and precipitation, some of which we may not yet know about, let alone understand.

Ironically, Langmuir sensed this when he made his optimistic projections. He told the academy meeting that "the ordinary concept of cause and effect cannot be applied" in the case of cloud seeding—there are too many unknowns. Then, with an intellectual recklessness that became the hallmark of research on weather modification after 1960, he explained that all seeding can do is alter the probability that precipitation will occur in a given situation. Researchers should look for just this effect in their statistics.

While acknowledging the importance of sound statistical analysis (which has not always been observed in rainmaking research), Dr. Braham concluded that our limited understanding of clouds and cloud systems has paced our progress. He explained, "In a sense, we are trying for a home run at a time when a bunt single might advance our cause somewhat faster." He added that "we should declare a moratorium on experiments in which the *primary* objective is to verify some change in precipitation at ground level."

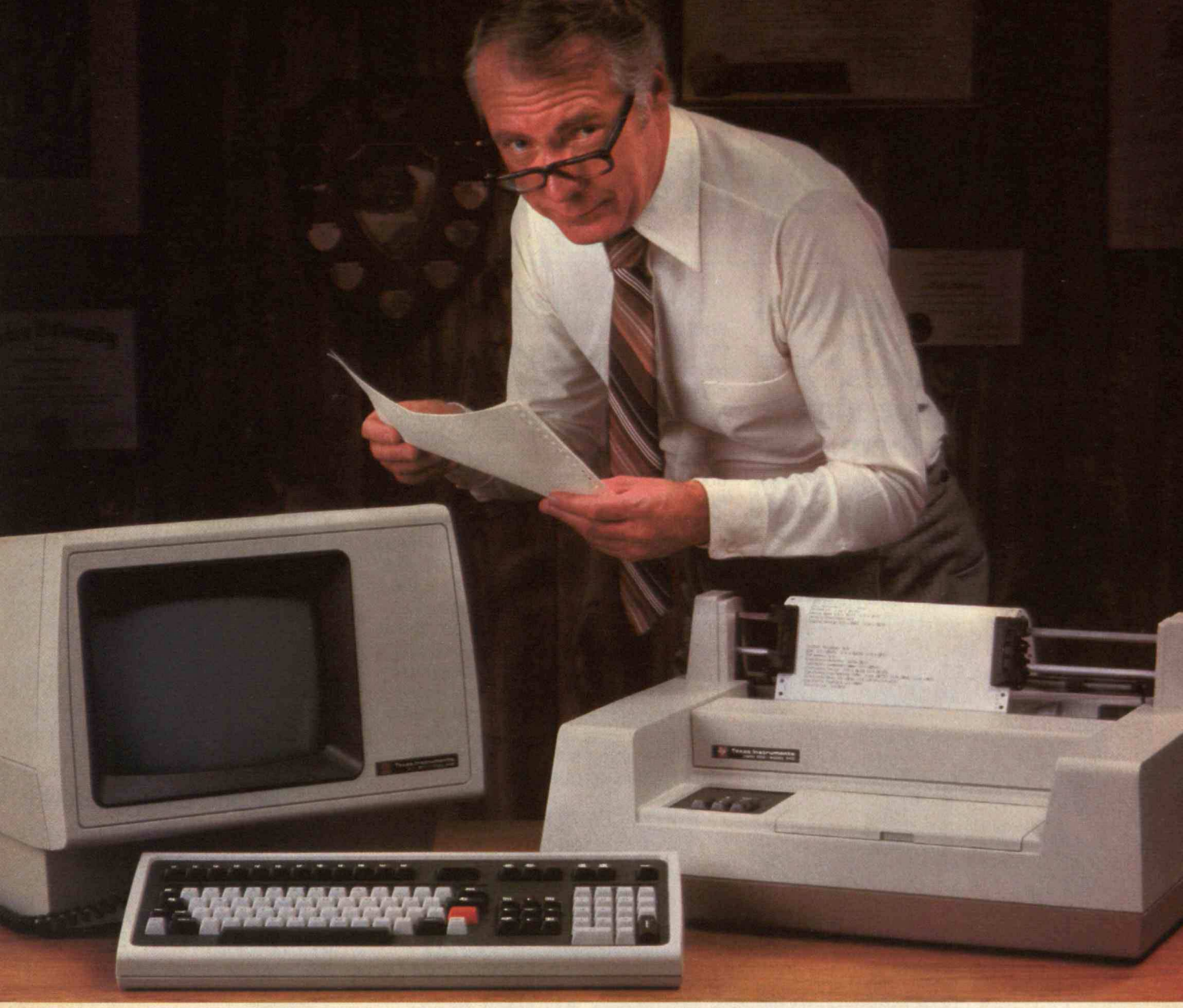
Chasing Rain and Rainbows

Congress is likely to insist on such a restriction if it does give NOAA new funds for weather modification. That would be asking a lot of researchers, who were told a few years ago by NOAA's Weather Modification Advisory Board that rainmaking "is scientifically feasible and within sight."

At that time, a major experiment to increase rainfall in a target area over Florida looked promising. Called the Florida Area Cumulus Experiment (FACE), it used silver-iodide seeding to encourage selected cumulus clouds to grow and merge into

(*Continued on page 87*)

ILLUSTRATION: MICHAEL McLAUGHLIN



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How Exxon's "energy is saving millions of

Bill Lockett's guidelines set the targets for Exxon's refineries; creative engineering helps reach them.

Oil refining is the largest consumer of energy in the petroleum supply cycle. In fact, energy accounts for about half of a refinery's total operating costs. Recognizing this, Bill Lockett and his colleagues at Exxon Research and Engineering Company (ER&E) developed a unique system to measure and analyze energy efficiency in refineries—a system that helped Exxon save 30 million barrels of oil in 1981 alone.

Developing accurate, but broadly applicable standards for energy use was no easy task. Refineries by nature are extremely complex energy networks, with a wide variety of processes operating from temperatures below freezing to more than 2000°F, and from deep vacuum to 3000 + psi. These processes consume and release energy in many different forms. Furthermore, feedstocks, product slates, and refining intensity vary frequently.

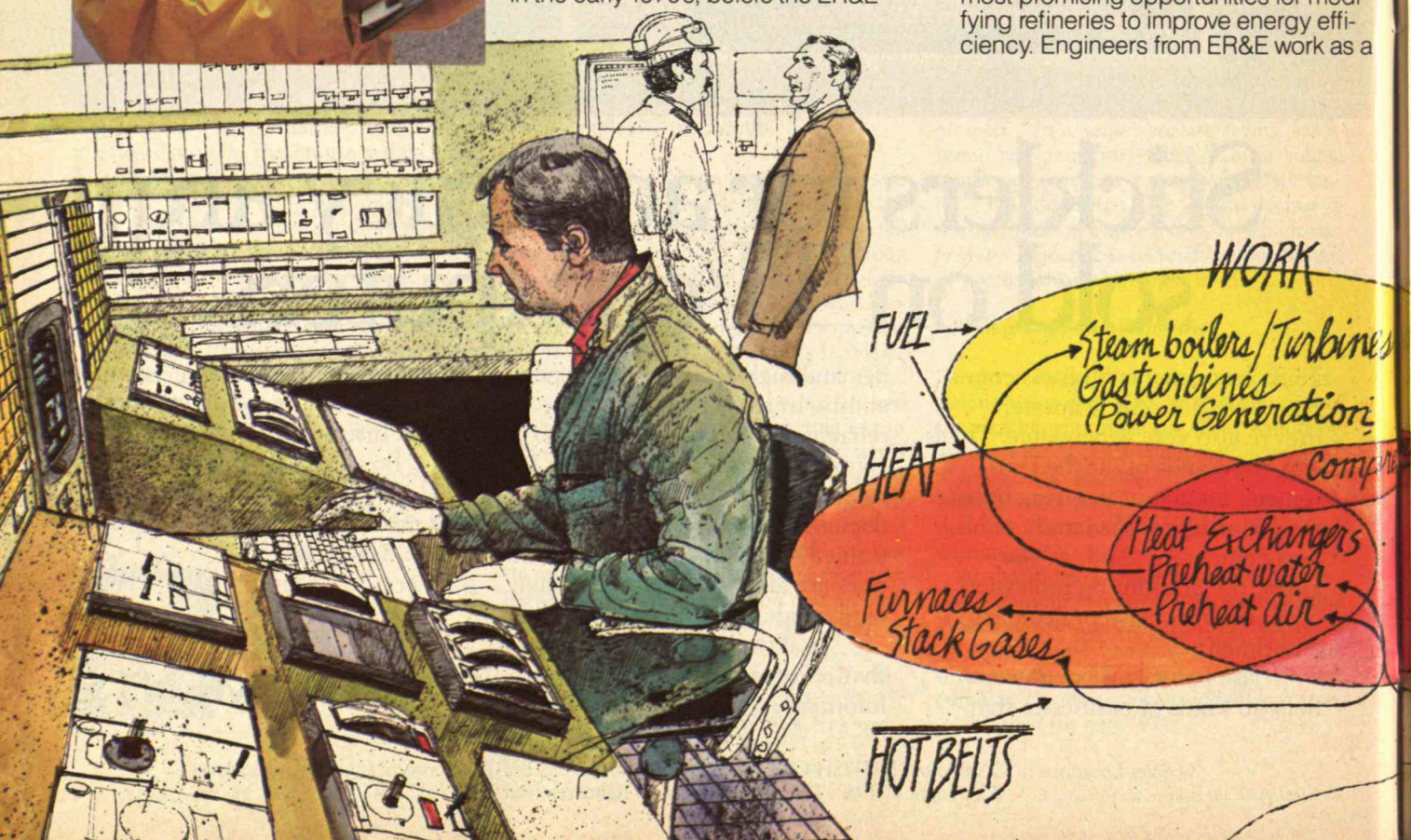
The Energy Guideline Factor System

Several approaches had been tried in the early 1970's, before the ER&E team led by Lockett devised Energy Guideline Factors (EGFs) to provide the basis for comparing actual plant performance to an energy-efficient plant doing the same job. EGFs were developed for each type of refinery unit, such as distillation towers, desulfurizers, or catalytic crackers. The factors take into account such variables as feedstock quality, processing intensity and throughput. Refinery engineers anywhere in the world can evaluate actual performance of their process units against these standards and can combine individual guideline factors into a customized energy-consumption yardstick for an entire refinery.

The EGF system has proved to be a real success. It is used in all of Exxon's refineries around the world and has been licensed to twenty-seven other oil companies as well.

The Site Energy Survey

Another major element in Exxon's Energy Conservation (ENCON) program is an on-site survey to identify the most promising opportunities for modifying refineries to improve energy efficiency. Engineers from ER&E work as a



management" system barrels of oil a year.

team with local refinery personnel to monitor and assess all aspects of energy use, treating the entire refinery as an integrated energy system. Synergistic conservation opportunities are sought, not only within the refinery, but also with neighboring industries and utilities. Projects which could foster cooperative energy efficiency, including heat integration and heat/power cogeneration possibilities, are considered.

Highly specialized computer programs help the team synthesize potential energy-saving alternatives, and evaluate them according to thermodynamic, operational and economic criteria. The results are used by refinery managements to plan and implement both short-term and long-range energy-saving programs.

Today, Exxon's refineries around the world are, on the average, 23% more energy-efficient than they were in 1973, and Site Energy Surveys completed to date have identified substantial additional energy-savings opportunities.

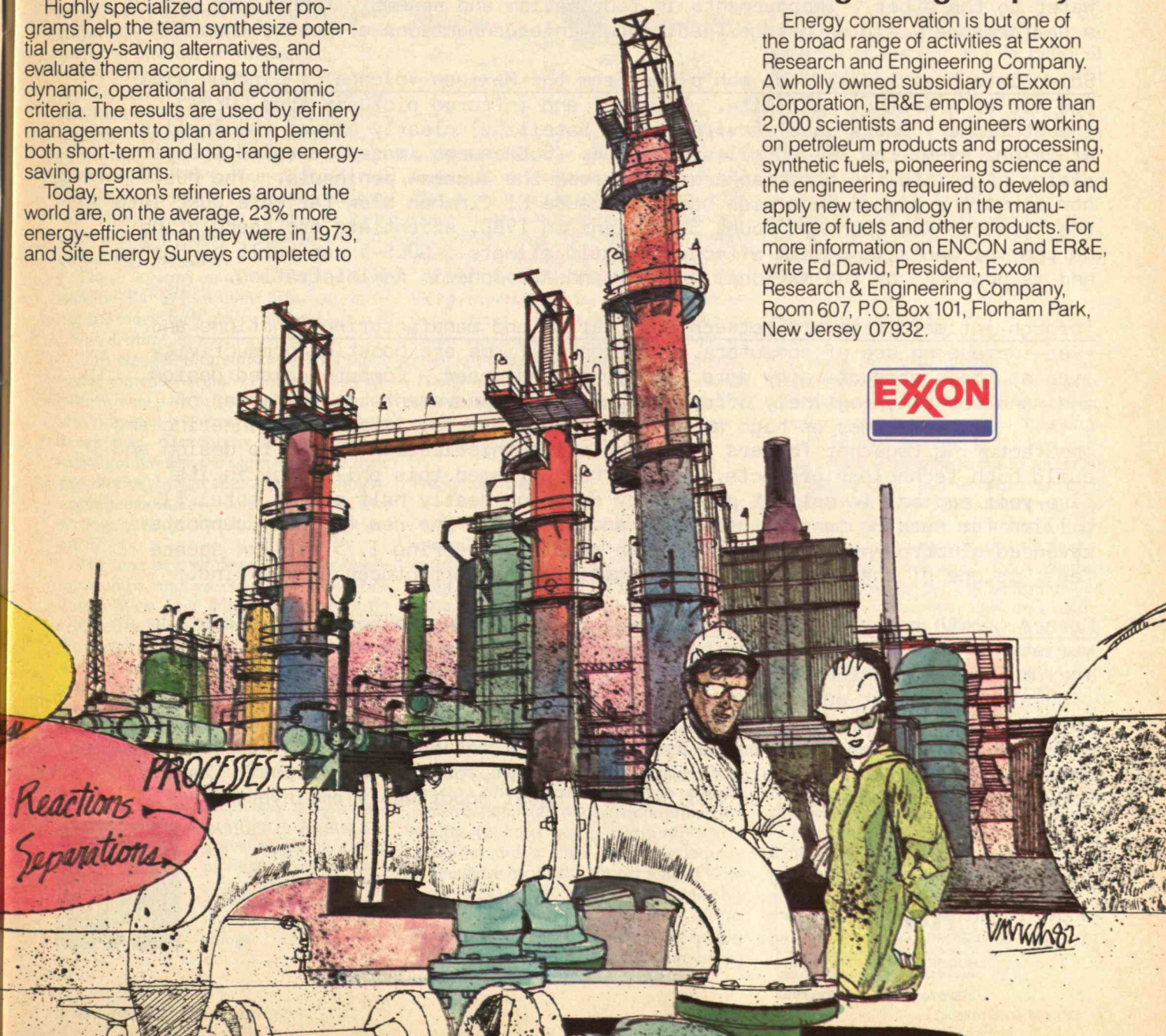
Hot Belts and Other Technologies

ER&E is applying a variety of other technologies in the search for energy savings as well. One concept is the heat transport loop, or "hot belt," that exchanges energy between multiple sources and sinks within the refinery, and even outside of it. High activity catalysts which permit lower reaction temperatures are being researched, as are low-energy separation processes such as membranes, and sophisticated computer control systems for on-line optimization of energy efficiency.

Exxon Research and Engineering Company

Energy conservation is but one of the broad range of activities at Exxon Research and Engineering Company. A wholly owned subsidiary of Exxon Corporation, ER&E employs more than 2,000 scientists and engineers working on petroleum products and processing, synthetic fuels, pioneering science and the engineering required to develop and apply new technology in the manufacture of fuels and other products. For more information on ENCON and ER&E, write Ed David, President, Exxon Research & Engineering Company, Room 607, P.O. Box 101, Florham Park, New Jersey 07932.

EXXON



For his pioneering contributions to geostationary communications satellites, Dr. Harold Rosen of Hughes has been given the prestigious Alexander Graham Bell Medal by the Institute of Electrical and Electronic Engineers. Rosen is credited with conceiving the first practical geostationary communications satellite, which orbits 22,300 miles high and appears to hover in the sky. A single satellite covers over a third of the globe. Early satellites orbited at low altitudes and would have required a large orbiting fleet and complicated tracking procedures if continuous communications were to be provided.

A complete 3-D microelectronic 32x32 array processor is significantly closer to being demonstrated now that Hughes scientists have fully interconnected a stack of two wafers. Each of the wafers has a 32x32 array of aluminum feedthroughs migrated through the silicon wafer, forming low resistance paths across the wafer. Micro-spring bridges made for each unit cell of the array connect one wafer to the other. Improvements in fabrication and assembly techniques led to a performance yield on bridge/feedthrough interconnections of better than 99%.

Scientists have tracked the ash plume from the Mexican volcano El Cinchon with the aid of a weather satellite. Daylight and infrared pictures from GOES-5 (Geostationary Operational Environmental Satellite) clearly showed the April 4 eruptions even from 22,300 miles in space. Subsequent images revealed the plume rising high into the stratosphere and across the Yucatan peninsula. The dust now rings the planet in a wide band. Because El Cinchon blew far more dust into the stratosphere than did Mount St. Helens in 1980, scientists are speculating on the volcano's long-term effects on world climate. GOES-5 was built by Hughes and is operated by the National Oceanic and Atmospheric Administration.

Through intimate teamwork between engineering and manufacturing functions and ever-increasing use of computers, electronics firms are boosting productivity even as their products grow more technically advanced. Computer-aided design and manufacturing routinely offer productivity improvements on the order of 4-to-1, and sometimes as high as 10-to-1. Furthermore, locating engineering and manufacturing together fosters the technical sophistication needed to design and build high-technology products. Hughes has stressed this philosophy in its five-year capital investment program by devoting nearly half of the total $1.5 billion for merging manufacturing and engineering. One new facility supports advanced electro-optical products. The complex, covering 1.75 million square feet, is one of the largest and most sophisticated structures of its kind.

Career growth opportunities exist at all levels at Hughes Support Systems for a variety of engineers qualified by degree or extensive work experience. They include systems engineers and software and hardware design engineers for major simulation and test equipment programs. Also, field engineering posts throughout the U.S. and the world offer travel, autonomy, and responsibility for the life cycle of Hughes electronics systems. Phone collect (213) 513-5235. Or send your resume to Professional Employment, Dept. SE, Hughes Aircraft Company, P.O. Box 9399, Long Beach, CA 90810-0463. Equal opportunity employer.

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Firming Up Foundations for the Future

In mid 1979 I was asked by the editors of *Omni* magazine to help celebrate their first anniversary by speculating about the future of science and technology. I have never felt that prophecy was one of of my strong points, so I declined.

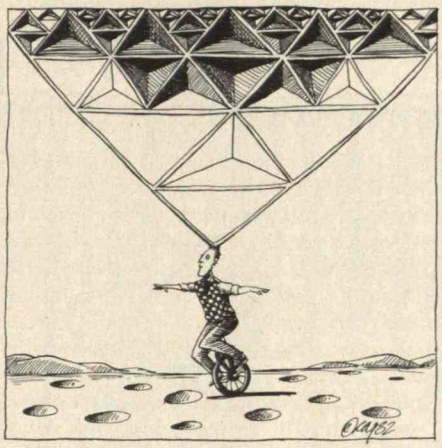
Others, however, seemed pleased with the opportunity, and the anniversary issue contained numerous replies. Isaac Asimov predicted that microprocessors would make it possible to totally automate society, "therewith removing the necessity for humans to indulge in dull and repetitious labor." Ray Bradbury opined that space travel was "commensurate with the birth of Jesus, Buddha, or Mohammed." Thor Heyerdahl spoke of "amazing things" that will be discovered at the bottom of the sea. Rene Dubos said that he saw no limits to "advances in technology and ways of thinking." Various scientists and engineers spoke with excitement about solar energy, recombinant DNA, ultraintelligent machines, homeostatic control of pain, and breakthroughs in the physics of elementary particles.

These visions made for stimulating reading. But as I sat in my armchair, turning the magazine's glossy pages, I felt as if I was drifting into a fantasy world.

This was the future discerned, all right, but it somehow seemed ethereal. Overoptimism was part of the problem, but that was not what bothered me. Hopefulness is acceptable, particularly on an anniversary, and besides, the sages had laced their prophecies with an appropriate amount of apprehension. No, something else was wrong, although I couldn't put my finger on it.

The next day, while rattling over familiar bumps and crevices on New York City's West Side Highway, I abruptly realized what was missing from those glowing visions of the future. It is all very well to speak of computers, lasers, and genetic engineering, but the actual road to the future unfolds before us every day, and anyone with eyes can see that it is full of potholes.

SAMUEL C. FLORMAN, a civil engineer, is author of *Engineering and the Liberal Arts, The Existential Pleasures of Engineering,* and *Blaming Technology.*



Seen from the vantage point of a rattling automobile, the great scientific and technological challenge of the future has little to do with electronics and less with space. It consists essentially of renewing and maintaining the engineering works put in place during the past century.

I soon discovered that this insight was being experienced by many people in many places. The ink was hardly dry on *Omni*'s anniversary issue when a wave of complaints and warnings about dilapidated public facilities seemed to sweep across the nation. One started to hear the phrase "deteriorating infrastructure" from all sides.

Decay and Disarray

A report that served to focus the widespread malaise was *America in Ruins*, issued in early 1981 by the Council of State Planning Agencies. This study's findings attracted the attention of the media and inspired a feature article in *Time* entitled "Time to Repair and Restore."

The facts by now have been widely disseminated. The nation's 42,500-mile interstate highway system is deteriorating at the rate of 2,000 miles per year—more than 8,000 miles already require total rebuilding. One of every five bridges now requires major rehabilitation or total reconstruction. Half of our communities are trying to cope with marginal water supplies and a third with inadequate wastewater facilities. Almost half of Conrail's lines in the Northeast will probably have to be abandoned in the near future. Ports, prisons, dams—almost all public facilities—are in a deplorable state of decay. Since 1965, the percentage of the gross national product invested in public works has fallen from 3.6 to 1.7 percent, a 53 percent decline. Federal aid programs are being cut and the municipal credit market is in disarray.

According to the Council of State Planning Agencies, one reason that this fast-developing crisis escaped broad attention is that the federal government does not have a separate capital budget. Thus, the decline in capital investment is obscured by the rise in annual operating expenses. The comptroller general of the United States also stressed this point in a report issued last year. But the Office of Management and Budget has resisted changes, maintaining that if capital investment becomes a separate area for policy decisions, political maneuvering would inevitably force the federal budget upward. In any event, states and cities, practically all of which *do* isolate capital expenditures, have neglected essential maintenance and renewal programs because of political timidity in the face of taxpayer revolts.

Don't Burn the Bridges

It is ironic that while public facilities are crumbling about us, the future of science and technology should still be seen in terms of glittering novelty. This view would be understandable if new techniques made it possible for us to forget all we had created, such as when we built railroads and simply abandoned most of our canals. But that is not about to happen, much as we may talk about sitting at home and communicating electronically.

People show no signs of being satisfied with seeing one another only on glowing screens. Not only do people want to move about, but the millions of tons of materials that form the basis of our civilization must still be transported by land, sea, and air—from mines to factories to distribution centers to consumers. One of the key arguments of those who decry present government policies is that the hoped-for financial recovery will be forestalled by a deteriorated transport network.

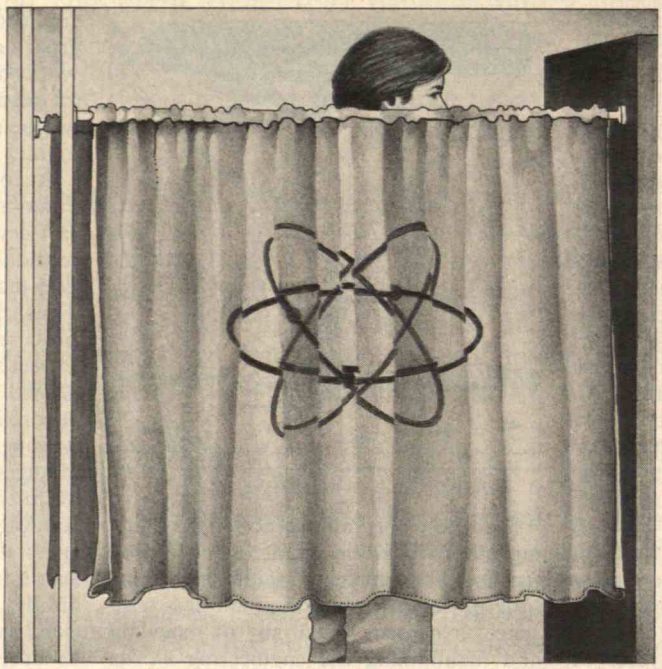
The situation is made worse by new technologies that create maintenance problems almost from the moment they are introduced. Plastic water lines leak unexpectedly, foam insulation proves injurious to the occupants of houses, new

(Continued on page 87)

ILLUSTRATION: RICHARD A. GOLDBERG

BY EDWARD J. WOODHOUSE

Managing Nuclear Wastes: Let The Public Speak



AFTER more than 20 years of commercial nuclear power, the federal government has yet to develop a broadly supported policy for managing radioactive wastes. Solving this problem is widely viewed as critical to the nuclear industry's future. The Department of Energy (DOE) and its predecessor agencies have approached waste management as if the significant problems were technical—that solutions should be left largely to nuclear engineers. As they converge on the "correct" technologies, members of the nuclear community, including DOE, attempt to persuade the public to take a "rational" view of radioactive waste. They assume that if they develop a technically sound plan, the public will automatically accept it. Unfortunately, this is an improbable hope.

First, acceptance follows from technical "correctness" only when people understand that an idea is sound. However, most people, including government officials, are ill-informed on nuclear issues, and misconceptions are prevalent. For example, respondents in a Washington State study averaged only 27 percent correct on a test concerning radioactive wastes and their disposal. (Random guessing would have produced 25 percent correct.) Pronuclear and antinuclear respondents scored about the same.

Nor can we look for a consensus of technical experts. Some prefer ocean burial to underground disposal, encapsulation in synthetic rock to borosilicate glass, and so on. And scientists may continue their support even when their favored technology seems unlikely to be chosen. Amplified by the media—and this is not meant simply to condemn the messenger—such expert disagreement will only increase public confusion.

Most importantly, many nuclear-waste decisions do not have technical answers. Should decommissioned power plants be dismantled or entombed in place? Should wastes be retrievable, and for how long? Should spent fuel be reprocessed? Should there be numerous small repositories or a few large ones? How much should be spent on managing waste compared with other pressing social concerns? How much say should state or local residents have? Unfortunately, the present political process is not designed to yield timely and widely accepted decisions on such issues.

Government Distrust

Americans ordinarily look to the president and Congress to reach compromise solutions that capture public sentiment while retaining technical soundness. In fact, at least five congressional committees are at work on the problem of managing nuclear wastes, along with DOE and the Nuclear Regulatory Commission (NRC). But even if they reach agreement rather than continuing their stalemate, it is unlikely that their decision would win public approval. All branches of the federal government rate relatively low in public-opinion polls, and many states have strenuously opposed federal efforts to impose waste repositories. In the words of one opponent, "From the local perspective, the three branches of the federal government and associated agencies all resemble the Westinghouse board of directors." There is little reason to expect such sentiment to disappear. (*See "Is the Nuclear Industry Worth Saving?" page 38.*)

When President Carter announced his official waste-management plan developed by a federal Interagency Review Group, he emphasized the need for widespread public participation and approval no fewer than 25 times. He called for "consultation and concurrence" rights for states and localities, together with special public hearings throughout the United States. Whether "concurrence" meant "veto" was never clearly specified, and public hearings held by DOE, NRC, and the Environmental Protection Agency have not counted for much. Still, the growing awareness in the late 1970s of the need for state and public approval was a hopeful sign.

In contrast, the Reagan administration's "National Plan for Siting High-Level Radioactive Waste Repositories," issued in February 1982, does not provide for public or local participation and reduces the state role to "consultation." (However, it does promise that DOE "will consider state concerns before completing any plans.") Only 7 pages of the 135-page document touch on public involvement; the primary focus is on technical issues.

In place of this "plan" that returns to the faulty assumption that technical solutions will magically lead to public approval, the nation needs a process that is perceived as legitimate even by those who do not get their way (or who are confused about radioactive wastes). The process would have to be built on the only political institution still looked on favorably by most of the public—elections. As political scientist Murray Edelman puts it, elections "quiet resentments and doubts about particular political acts [and] reaffirm belief in the fundamental rationality and democratic character of the system." This is partly because people are much

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ILLUSTRATION: IRENA ROMAN

more willing to accept risks chosen voluntarily than those thrust upon them.

Because few candidates take positions on radioactive-waste management, using elections will mean using referenda. There are several possibilities. Congress, DOE, and the president might agree on a plan and put it before the public for acceptance or rejection. There could be either a single vote on the entire package or a separate vote on several aspects of it. Even better, two or more technically sound options could be constructed for each major policy choice and the public asked to make a series of decisions that together would outline the U.S. strategy for waste management. In addition, each area near a proposed repository would need either a referendum or other procedure for negotiating—with time limits—an acceptable siting agreement.

Of course, the public could be asked to vote on whether nuclear power should remain a part of the nation's energy future, and if so, how big a role it should play. But even if the public opted to abandon nuclear energy, the problem of handling the considerable quantities of radioactive waste already generated remains.

A series of referenda would obviously provoke considerable interest—the media would flood the public with information on nuclear energy and raise public awareness. To assure that the issues are widely aired, DOE might fund televised debates or other public-information activities conducted by a range of nongovernmental groups. Government agencies would have to avoid taking sides, and the nuclear industry would also be wise to keep its dollars and publicists in check so people do not feel that the referendum's outcome is "bought."

In areas where repositories have been proposed, DOE might sponsor public hearings. Such hearings are now usually attended by government officials, industry representatives, environmentalists, and academics; the "public" is not there. But the government could pay travel expenses and an honorarium for a randomly selected group of citizens to attend regional hearings—as a microcosm of the general public, something like jury duty. Instead of continuing the poorly structured and overly technical focus of current hearings, communications professionals could distill and present the policy issues in a comprehensible format. And by measuring participants' preferences, opinion researchers could construct profiles of what the overall population thinks.

Needed: Public Servants

Whether the referendum process would be too time consuming, costly, and otherwise unwieldly would turn on how valuable the public perceives the referenda to be. Surely they would not exceed the cost of a presidential election, building an aircraft carrier, or the annual budget for cigarette advertising. Also, states and cities have been holding referenda for years, often on very complex issues. Several states have even held referenda on nuclear energy. Though the results have sometimes been controversial (partly because of massive spending by the nuclear industry), the public has generally regarded the process as legitimate. Abroad, widespread public participation in a Swedish referendum—in which all political parties agreed to abide by the results—helped decide the future of nuclear energy in that nation.

But referenda alone will probably not be sufficient—the process must be part of a broader change in the federal waste-management effort. If DOE cannot redress its overly technical emphasis, then responsibility for managing wastes should be moved to another agency that is prepared to pay more attention to public acceptability. And "attention" means dollars, in part: only a tiny share of DOE's current half-billion-dollar annual budget for research and development on managing radioactive wastes goes to nontechnical areas. Not only will the referenda cost money, but $100 million or more may be needed to pay for public services and other concessions to encourage an area to accept a major waste repository.

Government officials must get out of the business of trying to get the public to do what is "correct" and begin to function as public servants. They must ask what the public wants and then try to achieve it. Such a stance is not only ethical, it is pragmatic—federal program managers are unlikely to sell their version of reality to the general public or the local citizens who ultimately must accept the repositories. Letting the public make key policy choices on managing nuclear wastes is the best way to build renewed trust among government, industry, environmental groups, and citizens—both now and for the next thousand years. □

Piping Coal to the Southeast

BY PETER GWYNNE

Two issues dominate politics in the Western U.S.—water and energy. The region is rich in sources of power, such as oil, shale, coal, and uranium, but its chronic shortage of water jeopardizes efforts to obtain energy from such sources. The struggle between energy companies and water interests is typified by a long-lasting battle over an ambitious plan to carry coal out of the Rocky Mountain region to industrial areas in the Southeast.

The basic issue is one of supply and demand. Wyoming, a state with a population of less than half a million, has plenty of low-sulfur coal but little industrial capacity to exploit it. Oklahoma, Arkansas, and Louisiana have far too little of that fossil fuel to meet demand among their utilities and industries. Hence, those states want plenty of Wyoming coal—delivered as cheaply as possible. Railroads have traditionally moved the fuel from one spot to another. But almost a decade ago, a group of entrepreneurs came up with what they claim is a cheaper, more environmentally sound method—a slurry pipeline.

The concept of the slurry is simple. Coal is crushed into pieces the size of sugar grains and then mixed with an equal amount of water. The combination produces a heavy liquid "slurry" that is then pumped through an underground pipeline all the way from the Rockies to the Southeast. Pumping stations at intervals of 80 to 100 miles along the route boost the flow of the slurry.

Once at its destination, the half-and-half mixture is spun in a centrifuge to remove most of the water from the coal. The crushed coal is then fed into power plants.

A slurry pipeline, its proponents claim, could carry coal from one-third to one-quarter more cheaply than railroads can over the 1,400 mile route. Furthermore, a buried pipeline would avoid many of the problems associated with rail transport—most notably the seemingly endless lines of coal cars that clog up traffic in small towns where grade crossings intersect major roads.

Planning the Pipeline

Coal-slurry pipelines certainly work. For six years starting in 1957, the Ohio pipeline carried 1.3 million tons annually along the 108 miles north from the coal mines on the Ohio-West Virginia border to Cleveland on the shore of Lake Erie. The Black Mesa line, originating in northeastern Arizona, delivers 4.8 million tons of coal each year to the Las Vegas area 273 miles away. Since that line began operation in 1970, coal slurry has flowed through it 99 percent of the time.

Still on the drawing board, the Energy Transportation Systems, Inc. (ETSI) pipeline is a far more ambitious undertaking. According to present plans, a 40-inch-diameter pipe will, at full capacity, transport 30 million tons of coal annually from the rich Powder River Basin region around Gillette, Wyo. to power plants in Oklahoma and Arkansas and to a barge terminal on the Mississippi or in Cypress Bend, Ark., for shipment south to Louisiana. Estimates suggest that the pipeline will deliver coal to the Southeast at roughly three-quarters of railway costs. However, the project has encountered opposition and delays almost from the time it was conceived, shortly before the Arab oil embargo of 1973-74.

The San Francisco-based ETSI was originally established by Bechtel Corp. and the New York investment banking firm of Lehman Brothers, Kuhn, Loeb. Its original plan was to slurry coal from the Powder River Basin with brackish water from the Madison Formation, an aquifer that lies beneath parts of Wyoming, Nebraska, and South Dakota. The slurry would run through an underground line traveling almost straight in a southeasterly direction to White Bluff, Ark., the planned site of a complex of power plants. To match the pipeline's originally planned capacity of 25 million tons of coal per year, ETSI pointed out, the railroads would have to use 2,500 trains containing 100 cars apiece—hauling coal on the southeastern trip and returning empty.

With the Wyoming governor and legislature favorably disposed to the scheme, ETSI intended to start work on the pipeline in 1974. And as the magnitude of the oil crisis became clear and the necessity for a shift from oil to coal arose, ETSI's prospects seemed almost too good to be true.

They were. As the nuclear industry has learned in the past decade, large-scale energy proposals rarely come into existence without a time-consuming fight.

ETSI's troubles started quickly. In November 1974, Wyoming elected a new governor, Ed Herschler, who was far more suspicious of the slurry scheme than his predecessor, Stan Hathaway. That was the signal for a series of attacks on the pipeline proposal.

Water Worries

The objections, which have yet to quiet down entirely, fell into three basic categories. Railroads complained bitterly that the pipeline would unfairly take away a vital part of their business—and thereby force them to increase freight charges for customers shipping products other than coal. Environmentalists complained that the pipeline system might cause a variety of ecological aggravations. And a coalition of interests in Wyoming and surrounding states argued that the pipeline—and others that would inevitably follow it—would remove precious water from the region.

The railroads had sunk capital into expanded capacity to carry the extra coal that the nation would need, only to face the prospect of being undercut by the pipeline. Previous pipelines have been too short and of too small capacity to affect railroads noticeably, but this slurry line, railroad representatives complained, would. They argued that the pipeline would not be competing on the same grounds as the trains. It would not have the ability to deliver anything but coal, nor could it deliver to more than a few selected terminals. The pipeline, in other words, would not be part of an overall system of national transportation devoted to dropping off a variety of products at hundreds of different points. Rather, it was designed to skim off the railroads' best business and leave the trains with less profitable tasks.

Environmentalists' concerns were a

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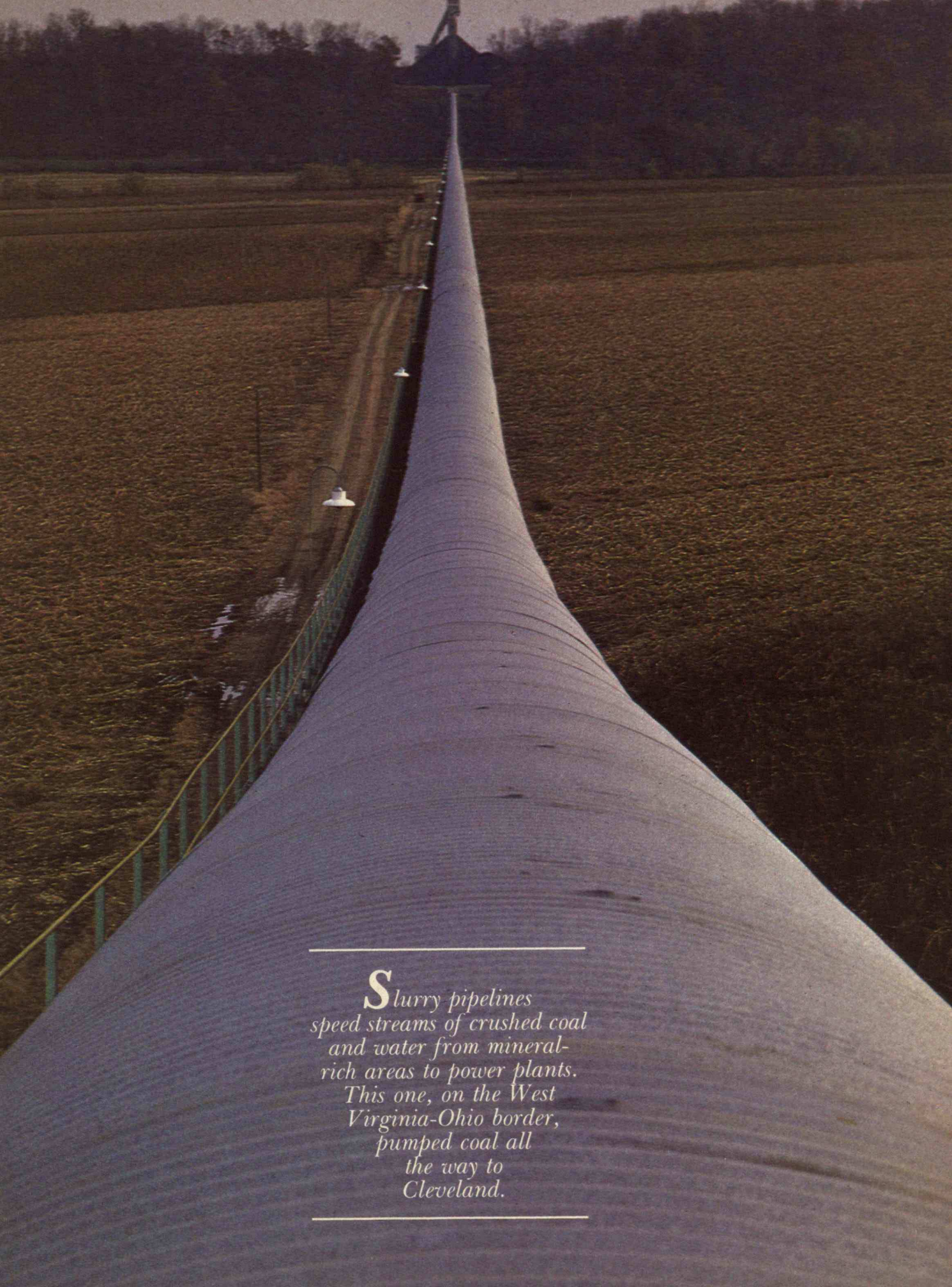
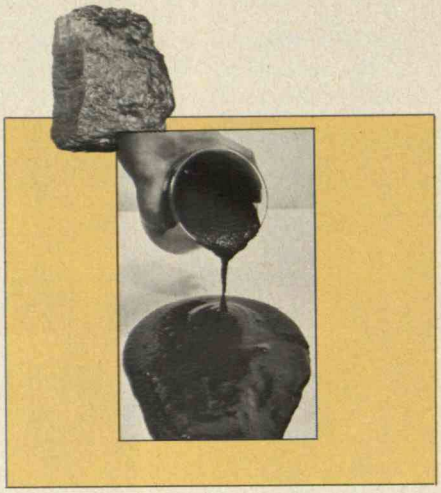
PHOTO: DAN McCOY, RAINBOW



Slurry pipelines speed streams of crushed coal and water from mineral-rich areas to power plants. This one, on the West Virginia-Ohio border, pumped coal all the way to Cleveland.



mixed bag. Opponents of the slurry line argued that the coal-crushing plants could jeopardize air quality near Gillette. In addition, they argued that possible spills from the line might contaminate rivers and streams en route. And the system would require almost 100 miles of new electrical transmission lines in Wyoming and would more than double the peak electricity demand in that state.

But the water issue dominated criticism of the ETSI pipeline. Nothing illustrates the shortage of Western water better than the fact that the Colorado River, according to interstate and international agreements signed over the years, is expected to provide more than 100 percent of its typical annual runoff to Mexico and the states that border it. Plainly, any scheme that threatens to remove water permanently from a Western state will automatically draw suspicion. ETSI's plan to pump 20,000 acre-feet of water annually out of the Madison Formation (an acre-foot of water contains about 326,000 gallons, enough to flood an acre of land to a depth of one foot) was not an exception.

Wyomingites of all stripes protested that their water should not be given away (or sold) to commercial interests and the soggy Southeast. Some suggested that the pipeline should be allowed to go ahead only if the recipients of the coal agreed to return the water. This proposition was economically impossible given the distance of the journey and the fact that the returning water would have to be pumped thousands of feet uphill.

In 1974, the governor of South Dakota threatened to sue Wyoming for any damage to South Dakota's water supplies caused by ETSI's removal of water from the Madison Formation. Ranchers and others protested vehemently that removal of water from the formation for the pipeline would cause the water table to drop. Then in 1980, a study designed to test that possibility revealed that the water in the formation was pure and potable rather than brackish. ETSI's future looked grim.

The company was already staggering from other blows. The states of Kansas and Nebraska originally refused the company permission to pass the line through those states. Kansas eventually relented, but Nebraska held firm, forcing ETSI to reroute the line around it. Money loomed as an increasing problem. As the estimated costs of the pipeline soared from $750 million to $3.5 billion, ownership of ETSI was diluted. Bechtel and Lehman Brothers, Kuhn, Loeb now share ownership with Atlantic Richfield Co., Texas-Eastern Corp., and Kansas-Nebraska Natural Gas Co. And Kansas-Nebraska has announced that it wants to sell part of its 20 percent share because of the growing capital demands on ETSI. (The partners expect to put up about 25 percent of the cost and borrow the rest.)

Despite incessant delays in the start of construction, ETSI occasionally received good news. It won permission in a series of court cases to cross under railroad tracks at critical points along the pipeline's route—vital victories because while the pipeline will run in a southeasterly direction, Western railroads travel predominantly from east to west. In June 1980, the Wyoming Department of Environmental Quality gave permission for three coal-crushing plants to be built, equipped with scrubbers to reduce the escape of coal dust into the air.

Extra encouragement had already emerged from Washington. A report issued in 1978 by the congressional Office of Technology Assessment gave the pipeline at least subtle approval. "The environmental choice between coal pipelines as opposed to increased railroad traffic primarily involves weighing the water use and temporary construction activity impacts of slurry pipelines against the noise, land-use disruption, and inconvenience resulting from increased train traffic." All other impacts examined are relatively insignificant or roughly equivalent for both modes.

But with the discovery that the Madison Formation water was clean, ETSI faced a crisis. The company had little prospect of using its planned water source; public opinion just wouldn't allow it. So in May of last year, ETSI looked for another supply.

It found one in the water from the Missouri River that fills the Oahe Reservoir in South Dakota, 270 miles from the Powder River coalfields. ETSI had considered using water from the South Dakota portion of the Missouri in its earlier studies. However, the rejection of the company's plan to take water from the Madison Formation, combined with the rapidly escalating cost of the whole project, made the Missouri water much more appealing.

According to an agreement signed in February betwen ETSI and South Dakota, the company can pipe up to 50,000 acre-feet of water annually from the reservoir during the 50-year planned lifetime of the pipeline project. ETSI will pay a $10 million signing fee and then $9 million annually, adjusted for inflation.

Taking advantage of a seller's market, South Dakota has also arranged for the 34-inch water pipeline to deliver 4,300 acre-feet of water free to farming communities along its route in the arid western part of the state. This fancy footwork made the deal more than acceptable to the government and people of the state and seems to have saved ETSI and the long-distance slurry pipeline concept. (However, conservationists, Sioux Indians, and several states downstream are challenging the agreement in court, arguing that it will divert water from other agricultural and recreational uses.) Optimists even predict that construction will begin this year—nine years later than originally planned.

Meanwhile, the attorney representing landowners in South Dakota reported in May that ETSI is seeking right-of-way agreements for a second coal slurry line to run through South Dakota. ETSI confirmed its interests in a second coal line but hasn't yet committed itself.

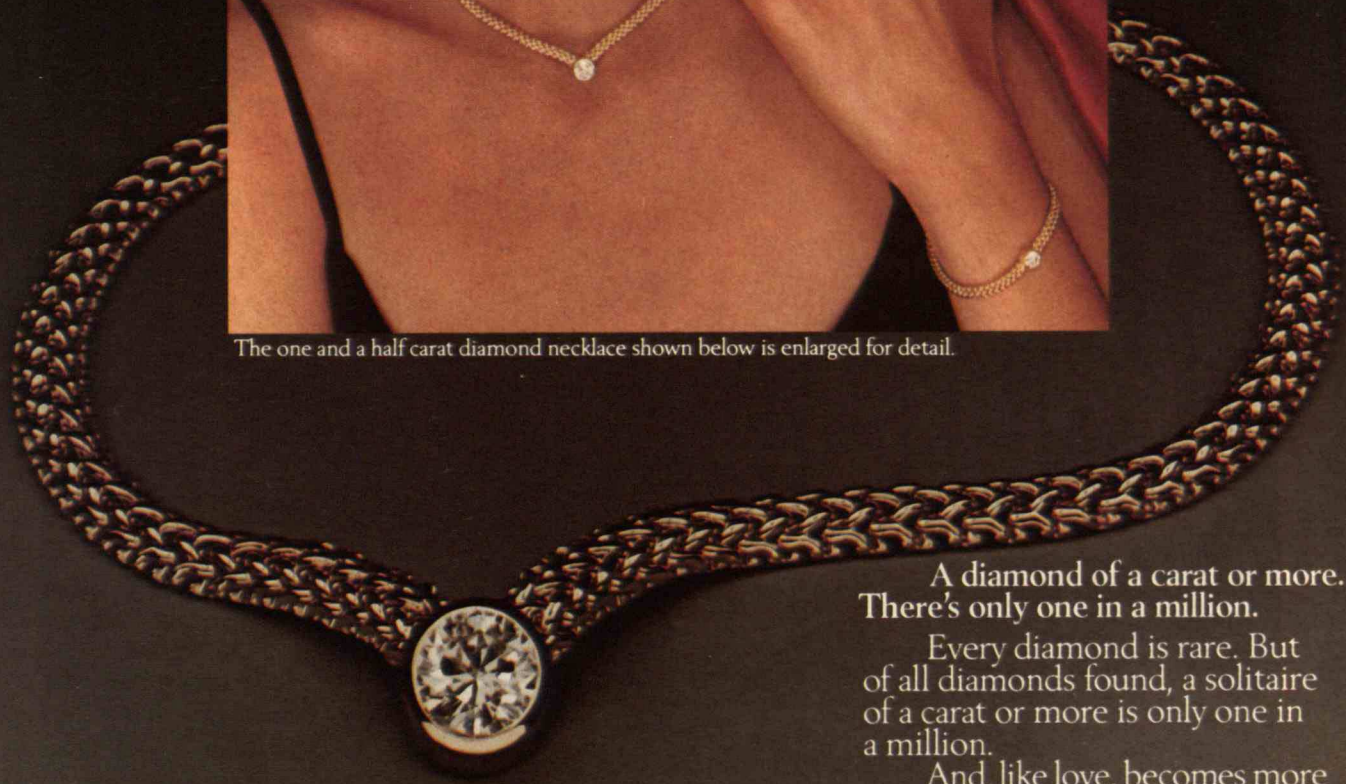
As might be expected, the railroads are not at all happy with ETSI's progress toward construction. However, given the court decisions awarding ETSI rights to cross beneath their tracks, there has been little that the railroads can do. Operating under the old assumption of "if you can't beat 'em, join 'em," the Burlington and Northern Railroad has announced that it is investigating the possibility of building its own slurry pipeline to carry coal from Wyoming to the West Coast.

Nonetheless, the whole episode has proved that the Western U.S., however bullish about unloading its energy reserves, guards its water tenaciously. ETSI's struggle shows that technology no longer records an automatic victory when it collides with environmental concerns. □

PHOTO: NATIONAL COAL ASSOCIATION

A carat or more.
A rare diamond. For that rare individual who never doubted you'd make it.

The one and a half carat diamond necklace shown below is enlarged for detail.



A diamond of a carat or more. There's only one in a million.

Every diamond is rare. But of all diamonds found, a solitaire of a carat or more is only one in a million.

And, like love, becomes more precious with time.

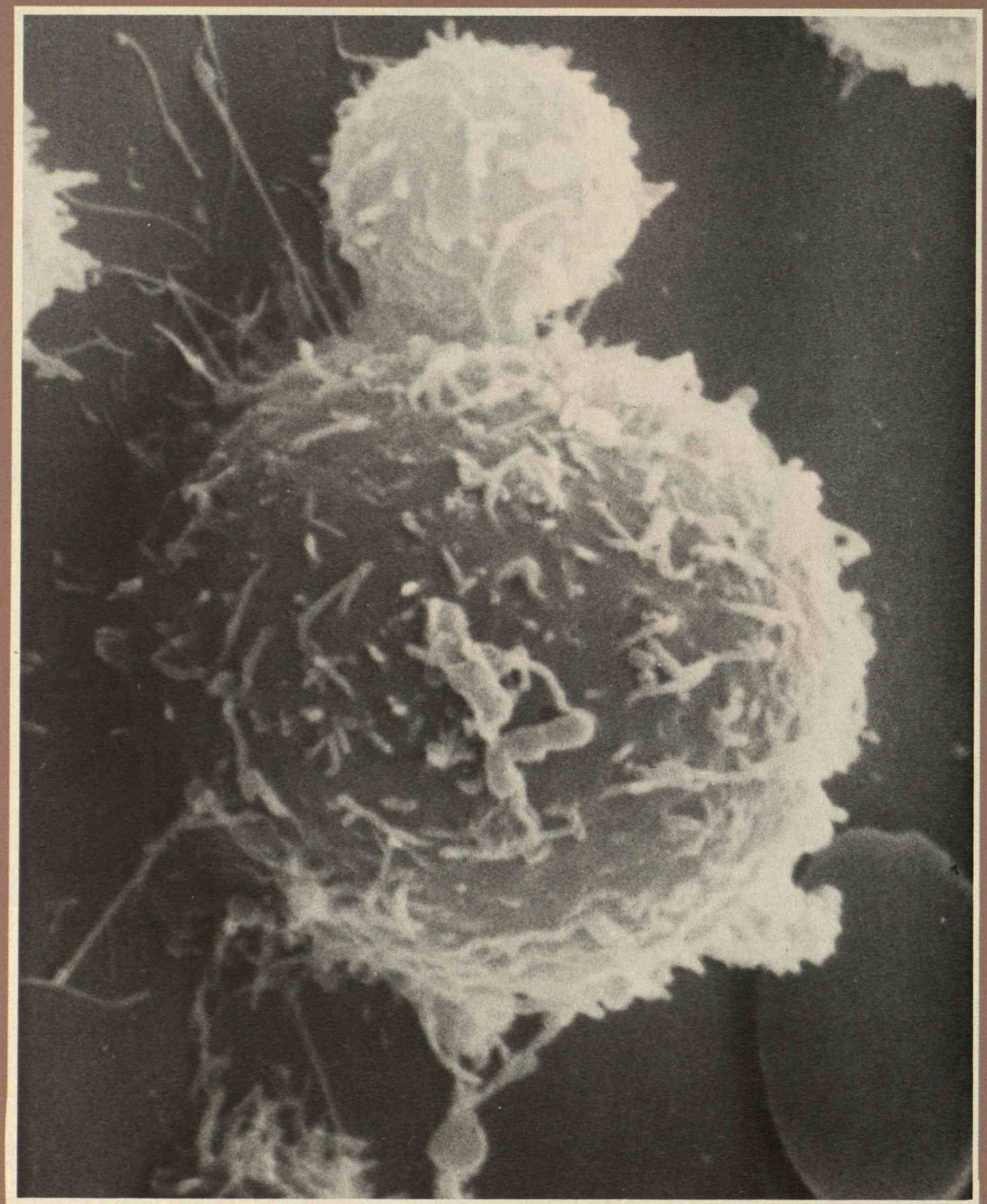
A miracle among miracles. Born from the earth. Reborn on a woman.

The extraordinary diamond of a carat or more.

Show the world you couldn't have made it without her.

A diamond is forever. De Beers.

Fusion of mouse spleen cells with mouse myeloma cell to make a hybridoma in culture as seen in a scanning electron micrograph.



In Search of the Magic Bullet

BY YVONNE BASKIN

Monoclonal antibodies, products of the revolution in biotechnology, are a valuable tool for detecting cancer and other abnormalities. But whether they will be effective in treating disease remains to be seen.

ANTIBIOTICS, medicine's most powerful weapon against bacterial infection, have been available for several decades. But generations of scientists have sought even more specific ammunition to ward off viruses and cancers, which are immune to antibiotic action.

The hottest prospect in this search so far is monoclonal antibodies. At first eclipsed in the public eye by the dramatic developments in recombinant DNA technology, monoclonal antibodies have recently become the darling of Wall Street. They have also dominated the limelight and an increasing percentage of research funds in the war against cancer, despite the fact that they have been tested on fewer than one hundred patients.

Conventional antibodies are protein molecules produced by the body's immune system in response to a foreign substance, or antigen. These antigens can be just about any substance recognized by the body as being a "nonself"—a foreign cell, molecule, virus, or even chemical. Antibodies have binding sites where they combine, in a lock and key fashion, with antigens. The antibody-antigen complex is recognized and destroyed by other parts of the immune system, or engulfed and digested by white blood cells called macrophages.

The immune system calls up a spectrum of antibodies rather than a specific one in response to every antigen. Conventional immunological techniques—injecting a laboratory animal with an antigen and drawing off the antibody-containing blood—provide hodge-podge of antibodies. Complicating this still further is the fact that the composition of the immune serum changes from animal to animal, and in the same animal from one immunization to the next. This makes isolating a specific antibody particularly difficult.

Developing a Limitless Source

For more than a decade prior to the discovery of monoclonals, immunologists actually knew of a type of cell that grows indefinitely in culture and produces a single antibody. These are myelomas—tumors of the immune system. However, there was no way to select in advance for the specific antibody that a particular strain of myeloma cells would produce. Therefore, manufacturing specific antibodies to attack specific antigen invaders was impossible.

Another approach entailed growing antibody-producing spleen cells taken from immunized mice. Many of these cells would manufacture specific antibodies, but they survived for only a few weeks at best, and the individual cells secreted only billionths of a gram of antibody.

Neither of these sources of pure antibody excited clinical scientists or commercial interests. What was needed was a cell line that was both immortal (as tumor cells are considered to be) and produced an antibody targeted to a specific antigen.

This need was finally filled in 1975 by Georges Kohler in the laboratory of Cesar Milstein at the Medical Research Council in Cambridge, England. They selected and produced large quantities of a single antibody that could latch onto a specific target.

To do this, Milstein and Kohler fused spleen cells from immunized mice with mouse myeloma cells that made no antibody of their own. The result was an immortal hybrid cell producing a single pure antibody—a *hybridoma*. Clones or exact reproductions of this cell, grown in an enriched laboratory culture medium, produced a potentially limitless supply of antibody.

Today, scientists around the world routinely perform this technique. It consists of immunizing mice with target antigens and removing their spleens, which contain large concentrations of lymphocytes, tiny antibody-producing white blood cells. The spleen cells are put in test tubes with myeloma cells and the chemical polyethylene glycol (PEG), and the mixture is spun in a centrifuge. The PEG acts like a glue, sticking the outer membranes of some of the cells together. After the slurry is washed, a few cells remain stuck together and begin to fuse. They are spread on a growth medium that permits only myeloma-spleen cell fusions to grow. After a few weeks, clones of individual fused cells are checked to see whether they secrete the antibody to the antigen of interest. With luck, a small fraction of the cloned cells do, and, being "immortal" continue to churn out the specific antibody indefinitely.

Milstein and Kohler never patented the

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PHOTO: HYBRITECH, INC.

hybridoma technique, but its commercial applications were recognized immediately. More than three dozen independent ventures in monoclonal antibodies have been launched, and at least twenty large chemical and pharmaceutical companies are developing monoclonals for a wide range of uses—from pinpointing new flu strains and typing tissues for organ transplants to purifying drugs.

But the most successful use of monoclonals so far is in diagnostic kits, which contain antibodies to test specimens of blood, urine, or tissues for blood type, viral disease, and other factors. The Food and Drug Administration approved four of these kits last year for use in diagnosing allergies, prostate cancer, pregnancy, and anemia.

The Elusive Tumor Target

But as profitable and useful as these kits are, the long-range hope of researchers is to direct monoclonal antibodies against cancer-causing agents. The problem is that antigens exclusive to cancer cells have yet to be isolated. What have been found are "tumor-associated" antigens, proteins that are more common on cancer cells than on normal cells. Various monoclonals developed from such antigens bind—although not exclusively—with breast, colon, lung, and pancreatic cancers, melanomas, and several types of lymphomas and leukemias in tissue culture or in mice.

There are several ways these antibodies could be used. They could be injected into the body as is or linked to drugs or radioactive isotopes. The latter have both the potential for killing cancer cells directly and pinpointing tumors for detection by diagnostic scanning devices.

Early reports of the treatment of cancer patients with monoclonal antibodies appeared in scientific journals last year. In leukemia patients at Harvard, Stanford, and the University of California at San Diego (UCSD), researchers found that monoclonal antibodies produced in mouse cells did bind with antigens on circulating tumor cells and the complexes disappeared from the blood. But cancer cells in the bone marrow, where red blood cells are produced, were apparently not affected, and more tumor cells soon appeared. Researchers now plan to use more intensive and longer-term treatment with monoclonals to see if results improve.

"It is unlikely that antibody treatment by itself will be useful in patients who have a lot of tumor cells," Dr. Jerome Ritz, a cancer researcher at Harvard Medical School, predicts. "But if you can get rid of the bulk of the tumor by chemotherapy or radiation, then it might be useful to give antibody to mop up the remaining tumor cells."

Since the monoclonals used so far are

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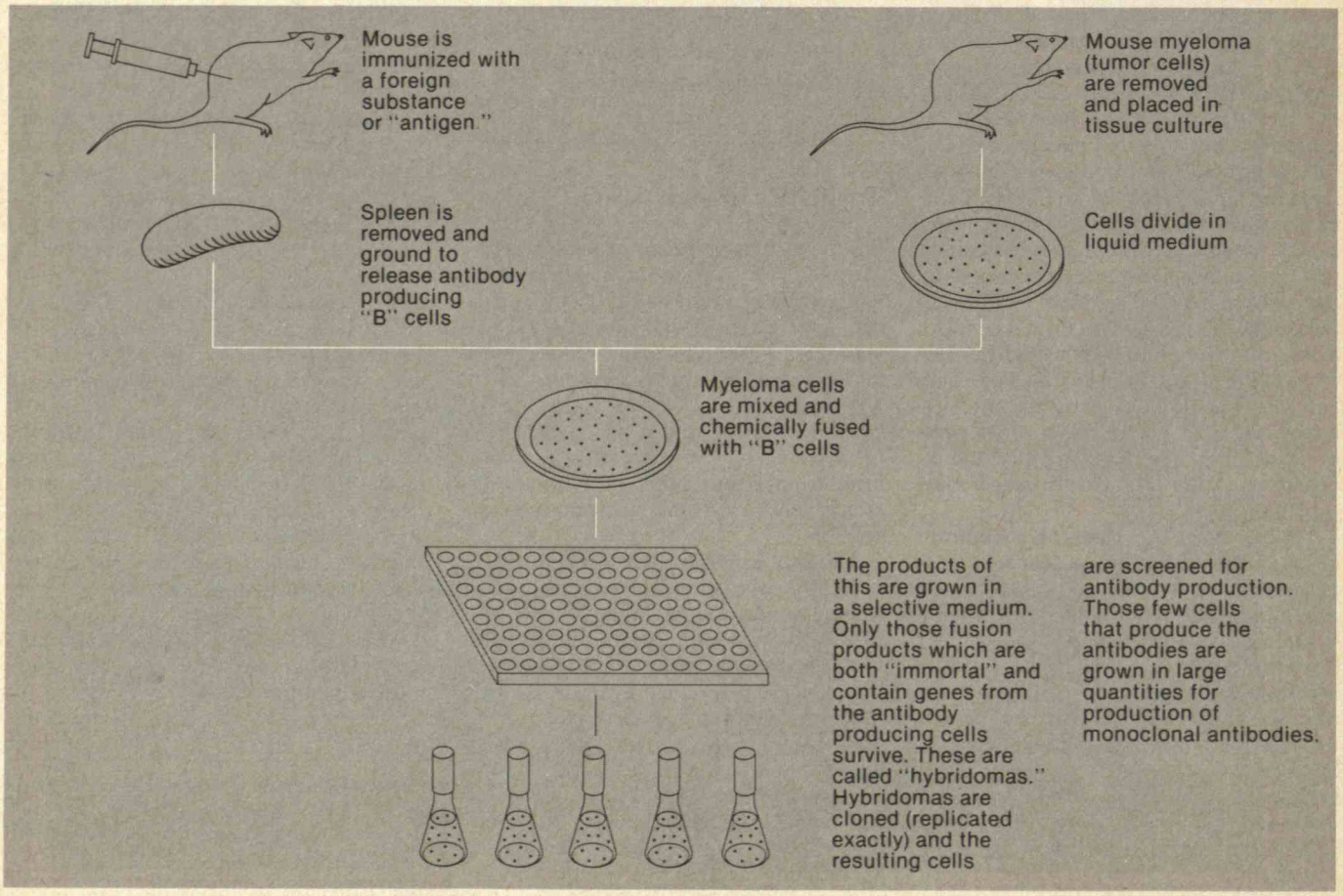


DIAGRAM: OMNIGRAPHICS

Synthetic Vaccines: Another Advance in Modern Immunology

BY CHRISTOPHER D. EARL

VIRAL diseases are far easier to prevent than to cure. Rabies, to take an extreme example, is fatal unless the victim is immunized with a vaccine before symptoms appear. But manufacuturing vaccines for many viruses is difficult and costly. To overcome these problems, researchers have developed a remarkable new technique: the chemical synthesis of vaccines.

Synthetic vaccines work the way conventional vaccines do—by preparing the body's immune system to rally against an infectious agent. The difference is that artificial vaccines contain no virus or viral products. Rather, they are made from scratch in the laboratory using amino acids, the building blocks of proteins. Researchers chemically link together a short chain of amino acids into a "synthetic peptide." The sequence of acids in this peptide corresponds exactly to the tiny part of a whole virus protein that the immune system recognizes. Recent experiments have shown that this synthetic peptide does indeed sometimes immunize an animal against live virus.

In conventional vaccine preparation, by contrast, viruses are grown on host cells in laboratory cultures. Vaccines are made from killed virus or purified viral proteins. These products are much larger and more complex than those made from synthetic peptides. Not all viruses, however, can be grown in the laboratory. The necessary host cell may be unavailable or the killed virus highly unstable. In some cases, contamination is almost unavoidable. Even worse is the chance that some live virus will sneak through the killing process and cause an outbreak of the disease it is meant to prevent.

Though the techniques are still experimental, many scientists are excited about the potential of artificial vaccines for freeing them from the limitations of standard vaccines. Small peptides are easy to construct and keep well even without refrigeration. They bear no threat of infection, since they are made without any living agents. The critical problem in developing any artificial vaccine, however, is identifying the peptide fragment that will stimulate a strong immune response to the virus.

The first success has been with foot-and-mouth disease virus, a scourge of livestock on every continent except Australia and North America. Investigators at the Scripps Clinic in La Jolla, Calif., and at the Animal Virus Clinic in Surrey, England, tested many synthesized fragments of this virus protein and came up with one that worked. Just 200 millionths of a gram of the peptide was enough to protect a guinea pig from the natural, infectious virus. The peptide, only 19 amino acids in length (less than one-half percent of the entire protein), is now being tested in cattle and swine.

The breakthroughs in this technology have depended in part on recombinant-DNA technology. Before synthesizing antibodies, scientists had to decipher the DNA sequence that makes up a viral protein gene. From the genetic code, as spelled out in the DNA sequence, they can predict the amino-acid sequence of the protein coded by the gene. But the amino-acid sequence does not directly indicate which parts of the protein the antibodies will recognize. To determine this, scientists must make an educated guess at the natural folded structure of a complete protein chain.

Hence, they use sophisticated computer programs to analyze the protein's structure and determine its most likely folded conformation. Those parts that appear to lie on the outermost portion of the folded protein are prime candidates for antibody recognition. Researchers synthesize a number of these parts and test them in lab animals for their immunogenicity.

According to Richard Lerner at the Scripps Clinic, the next targets for artificial vaccines will be such well-studied viruses as rabies, hepatitis B, influenza, and polio. In the case of polio, the common Sabin vaccine is "attenuated" virus—alive but lacking any disease-causing properties. Administered orally, it is ineffective in the tropics, where bacteria in the human gut interfere with the action of the vaccine. Moreover, in rare cases the virus is somehow reactivated in the gut of an infant who receives the vaccine, and the child's unimmunized mother catches the disease. Says Lerner, "The argument for a synthetic polio vaccine comes down to a moral question: How can you infect people with a living, replicating agent whose main feature is change, and then walk away?"

The new technology also holds great promise for cancer research. Numerous labs have now isolated supposed "cancer genes" of animals and humans—DNA that under certain conditions appears to code for proteins involved in tumor development. Researchers hope that the methods for making synthetic peptides will help produce monoclonal antibodies against these proteins. Mice will be immunized with the specific peptides, and their lymphocytes fused into hybridomas (*see the accompanying article*). At the very least, these antibodies will help scientists isolate and purify the proteins for study.

Indeed, synthetic peptides greatly increase the power and specificity of monoclonal antibodies. Not only can scientists obtain large quantities of antibody to counteract specific antigens; they can now immunize people with synthetic peptides and choose precisely what those antigens will be.□

Christopher D. Earl is a graduate student in the Division of Cellular and Developmental Biology at Harvard University.

mouse antibodies, scientists expected patients' own immune systems to eventually react and make antibodies against the foreign proteins, cutting down their effectiveness. "We are seeing patients making antibodies to the monoclonals after repeated doses, but so far we've been able to overcome that by using larger doses," UCSD researcher Dr. Ivor Royston says. Whether this immune reaction will pose a serious threat to therapeutic uses is not yet known.

Many labs are searching for reliable ways to obtain hybridomas that produce human antibodies, but several problems remain. Antibody-producing human lymphocytes fused to mouse myeloma cells are largely unstable, and a major effort has been launched to develop suitable human myeloma lines for fusion. Another problem is getting human lymphocytes that produce the desired antibodies. Humans can't ethically or legally be injected with viruses or cancer cells to provoke an immune response. So this either is done in cultured cells, or antibody-producing cells are taken from patients who already have cancer.

The most dramatic demonstration of a monoclonal's effectiveness as an anticancer agent was in a 67-year-old man with a malignancy of the lymph system called lymphoma. Two years of treatment with standard anticancer drugs and even the experimental antiviral protein interferon had failed to control the cancer. So in April of last year, researchers at Stanford University School of Medicine gave the patient a series of injections with monoclonals directed specifically against the antibodies produced by his own tumor cells. A year and a half after the procedure, the patient is still in remission.

Two types of cell fusions were used to tailor a mouse monoclonal antibody to fight the patient's lymphoma. Ironically, the most specific antigen on the surface of the lymphoma cells is the antibody expressed by those cells. However, human lymphoma cells produce too little antibody on their outer membranes to raise an immune response in mice, so the lymphoma cells were fused to normal human lymphocytes to increase their production of antibody. The product of this fusion was injected into a mouse, which responded by producing an antibody to the lymphoma antibody. The mouse's antibody-producing spleen cells were then fused with mouse myeloma cells to make a hybridoma that synthesized a specific antilymphoma antibody.

This laborious process took six months and enormous expertise. Whether it will ever be streamlined enough for widespread use is questionable. However, Dr. Royston, who is attempting to use the Stanford method in other selected patients, thinks that if monoclonals prove to be an effective cancer cure, they are well worth the effort of producing them.

Another promising but limited approach is being tested at Harvard Medical School and the Sidney Farber Cancer Institute by Drs. Jerome Ritz and Stuart Schlossman. They use monoclonal antibodies to make bone-marrow transplants possible for leukemia patients who would otherwise be ineligible because they lack a matching donor. (Bone-marrow cells can tolerate only limited doses of anticancer drugs and radiation. Leukemia victims who have siblings with matching tissue types can be given bone-marrow transplants after treatment with high doses of cancer-killing drugs and radiation, but those without suitable donors cannot.) Ritz and Schlossman's approach has been to remove some of the patient's bone marrow, treat it with monoclonal antibodies to destroy the cancerous cells, and then freeze the marrow for later reinfusion into the patient.

The treatment is not benign—the patient must still undergo massive assaults with drugs and radiation. But candidates for the transplants have all been patients who have suffered relapses after undergoing standard therapy and have very poor prognoses. In contrast, the first two leukemia patients treated with monoclonal antibodies were still doing relatively well 18 months after treatment.

Early results from scattered trials have convinced many researchers that the brightest future for monoclonals in cancer therapy and diagnosis is as carriers. Dr. Stanley R. Order of Johns Hopkins University has reported that conventional antibodies linked with iodine-131 can extend the lives of patients with inoperable liver cancer by delivering extra-heavy doses of radiation straight to the tumors. But iodine, which is bioactive, tends to be stripped off monoclonal antibodies by enzymes in the blood. Royston's group at UCSD has overcome this by using an inert isotope, indium-111, linked to monoclonals.

The excitement over using monoclonals in cancer therapy has overshadowed research into a broad range of other promising possibilities:

☐ A group of cell-surface molecules called the HLA (human leukocyte antigen) complex forms the chemical basis of "self," letting the immune system distinguish between body cells and foreign invaders. But sometimes this system goes awry, and the immune system sees "self" as "foreign." The result is an "autoimmune" disease. Studies show that chronic disorders such as multiple sclerosis, rheumatoid arthritis, and diabetes may be autoimmune disorders. More than 40 diseases have been associated with various HLA markers. Researchers have developed monoclonals targeted to a handful of specific HLA markers that are expected to be useful tools for studying this little-understood phenomenon.

☐ Monoclonal antibodies are being tested for rapid diagnosis of bacterial and viral infections, such as various strains of flu, malaria, and a potentially deadly African disease called Lassa fever. The strain of virus responsible for each disease has a distinctive coat of proteins to which monoclonals can be targeted.

For some infections such as hepatitis, monoclonal antibodies could provide "passive" immunization, supplementing the patient's own immune response.

☐ In a common screening technique called amniocentesis, a physician pierces a pregnant woman's womb with a needle and withdraws fluid from the amniotic sac to obtain fetal cells to test for genetic defects. This procedure can be risky—if the fetus is pierced it can die or abort. Dr. Leonard Herzenberg of Stanford and others are developing monoclonal antibodies targeted specifically to markers on the surface of fetal cells. Using this method they hope to isolate fetal cells in a sample of maternal blood, thereby eliminating the need to perform amniocentesis.

☐ Monoclonals are being targeted for valuable roles in drug purification. In a technique called "immunoaffinity chromotography," antibodies attached to beads or gel are used to bind contaminants or materials such as hormones and proteins and separate them from production batches. Monoclonal antibodies, with their high purity and specificity, may broaden the industrial uses for this technique, particularly for purifying interferon, insulin, and other products. ☐

How Antibodies Work

WHEN a potentially harmful foreign substance enters the body, the immune system must be able to detect and eliminate it. The means for starting, controlling, and ending a mammal's immune response are amazingly complex and little understood. But the part of the response that results in antibody secretion has been illuminated.

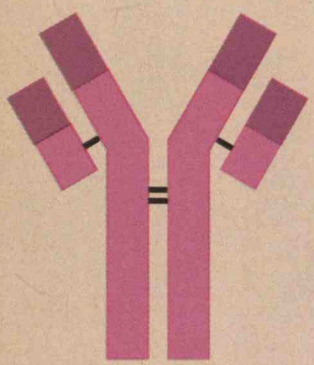
Antibodies are synthesized in a particular type of white blood cell called "B-cell" lymphocytes. These B cells detect foreign substances, or antigens, in the blood and lymph fluid as it passes through the spleen and lymph nodes. Each B cell makes antibodies specific to a particular antigen. But to protect the body from an antigen to which it has never been exposed, an enormous diversity of B cells produce millions of different antibodies. This diversity ensures that almost any foreign substance will be recognized as "non-self" and tagged for elimination from the body.

So when a virus is carried by the blood to the spleen, it is likely to run into a B cell that can make antibodies against proteins in its outer coat. The antibodies, anchored like sentinels on the B-cell membrane, recognize the virus and bind to it. The stimulated B cell then begins to divide rapidly, creating thousands of clones of itself. These clones then develop into highly specialized "plasma cells," which manufacture and launch into the blood stream vast quantities of antibodies.

This profusion of antibody molecules binds to the rest of the invading viruses. Other parts of the immune system then recognize the bound antibodies. For example, white blood cells known as macrophages engulf and digest small antigens that are covered with antibody molecules. If the invader is a bacterium or other cell (possibly some kinds of cancer cells), elements in the blood may bind to the complex cells and antibody, releasing special enzymes to perforate the cell membrane and killing the cell.

When the circulating antibodies have helped clear the body of an invading antigen, the plasma cells die and the antibodies disappear from the blood. But the immune system doesn't forget what happened. Back in the early stages of the response, when B cells proliferate, certain cells are set aside as "memory cells"—B cells that make an antibody for the antigen and await its next appearance.

The memory cells markedly increase immunity to an antigen. (Vaccination provokes the immune system to prepare memory cells for a disease-causing microbe it has never before encountered.) Thus, the immune system will be ready to respond more strongly and quickly if the antigen reinvades. A person might never feel symptoms from the second infection by a virulent microorganism such as mumps or measles viruses. Immunity, like many things in life, is better the second time around.—*C.D.E.* □



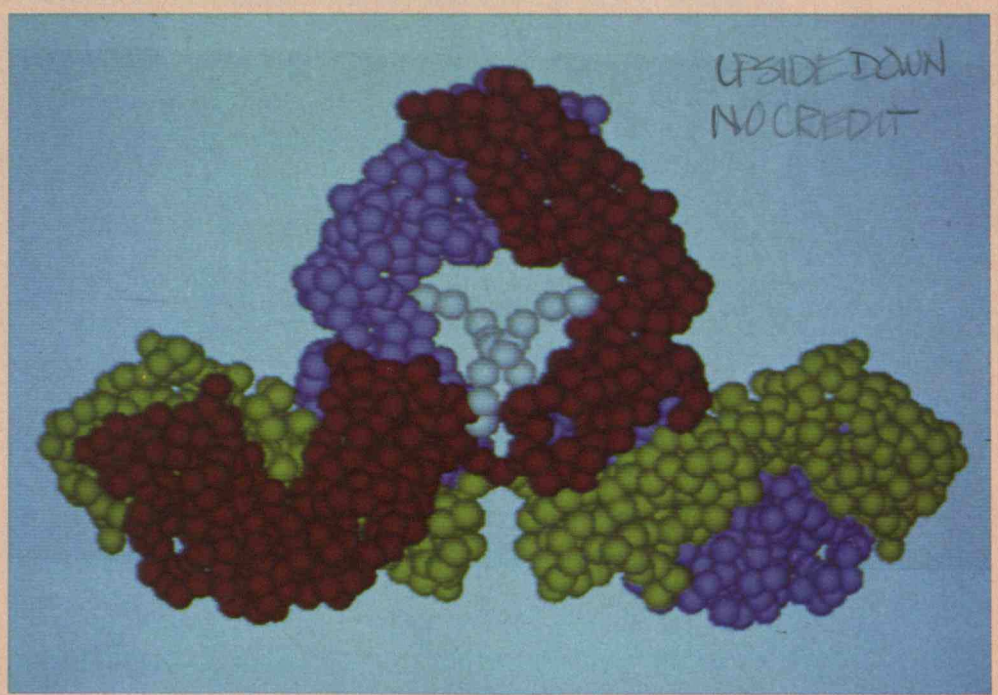
Variable regions

Constant regions

Disulfide bond holds the chains together

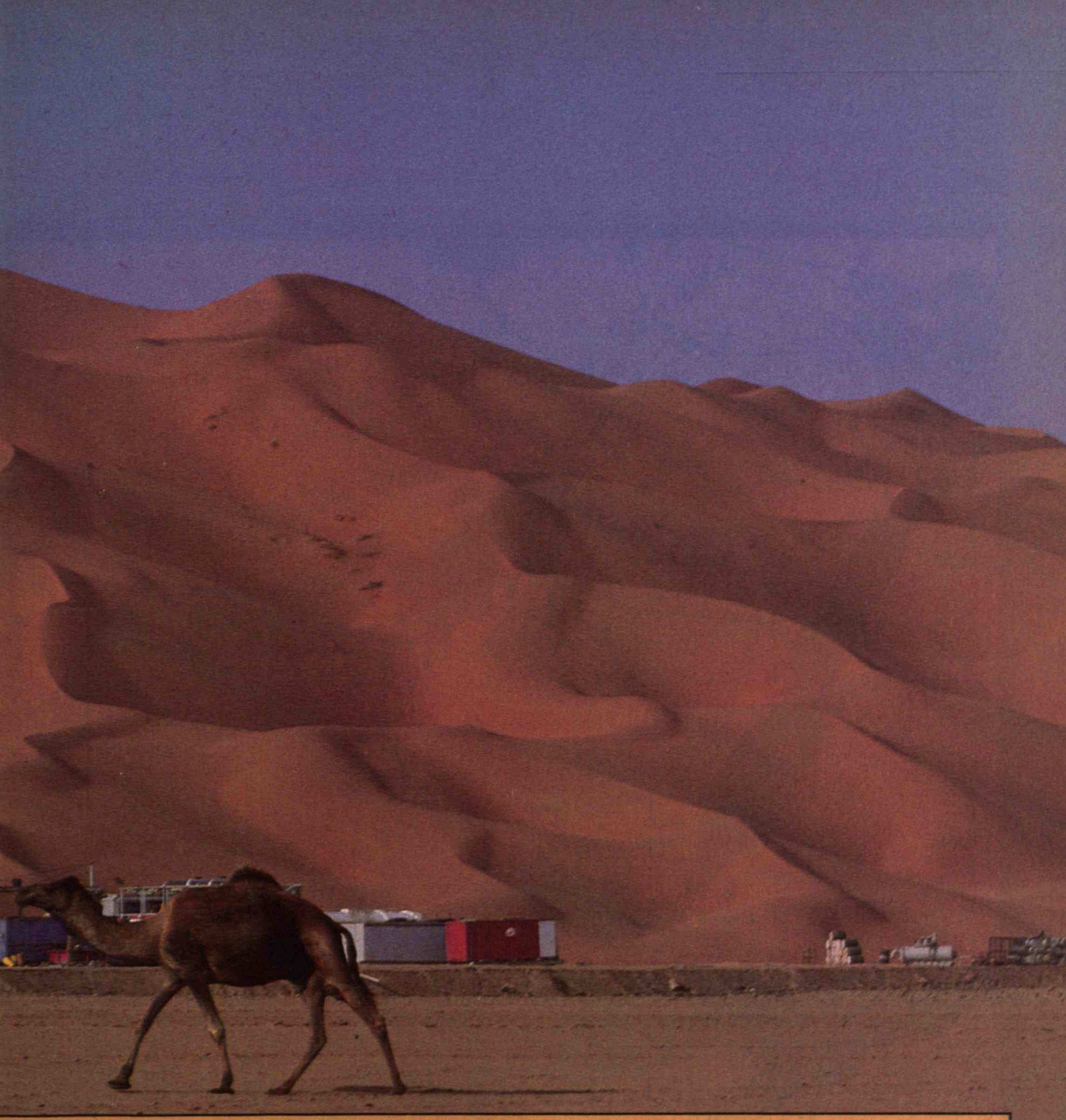
Above:
The variable regions of an antibody contain a sequence of 220 amino acids which recognize and bind to a specific antigen. Once the variable regions have folded together to form the antigen-binding site, the constant region determines how the antibody carries out its immunological task in the body—that is, how it will deal with the invading antigen.

Below:
An antibody molecule is made up of four protein chains. In this model, generated with a computer by Richard J. Feldmann of the National Institutes of Health, the spheres represent the amino acids, the building blocks of all proteins.



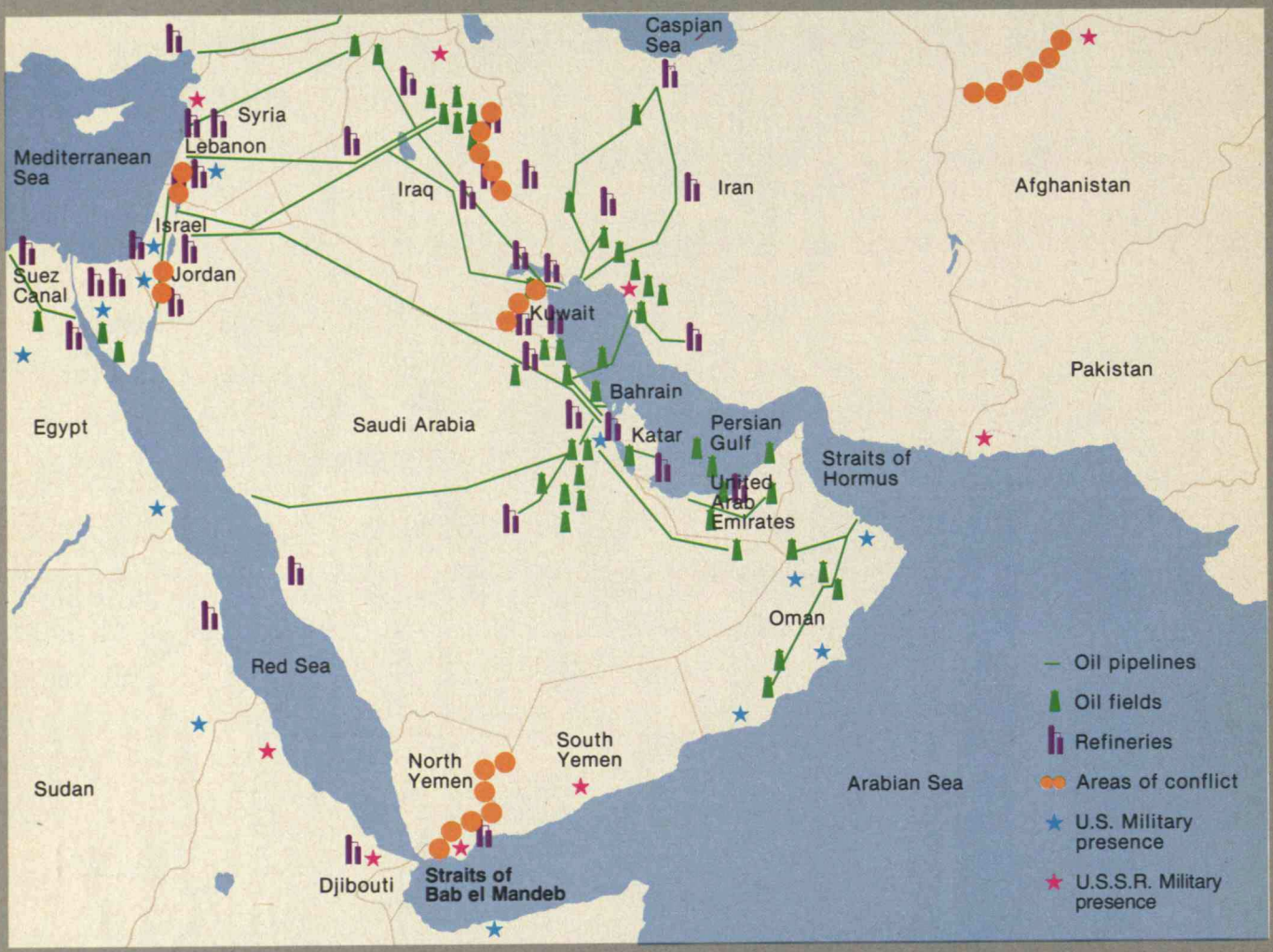
Power and Politics in World Oil

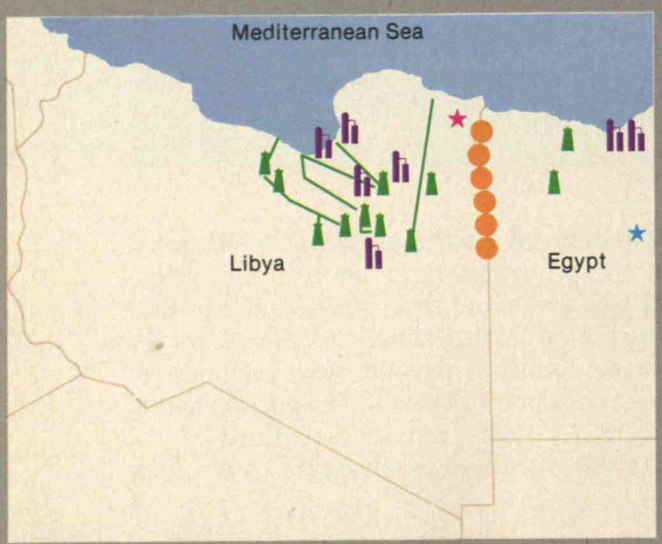
Like air and gasoline in an automobile engine, economics and politics make a volatile mixture for the world oil market.



THOUGH there has recently been more oil in the marketplace than anyone knows what to do with, a feeling of apprehension persists. We know that oil is a finite resource upon which the world is profoundly dependent. We remember how a handful of producers shook the market for this critical commodity almost ten years ago, causing a fourfold price increase in a few weeks. We sense that these producers have since 1973 consolidated the position that gave them unprecedented control of the market. Indeed, the 13 producing countries that are now members of the Organization of Petroleum Exporting Countries (OPEC) today provide one-third of the world's oil; half of all exported oil comes from

BY NAZLI CHOUCRI





The religious split in the Moslem world

Country	Population	Sunni Moslems	Shia Moslems	Other
Egypt	41,990,000	92%	0	8%
Lebanon	3,160,000	27%	29%	44%
Syria	8,980,000	70%	16%	14%
Jordan	3,190,000	93.6%	0	6.4%
Iraq	13,080,000	32%	63%	5%
Iran	38,080,000	5%	93%	2%
Bahrain	370,000	60%	40%	0
Saudi Arabia	9,292,000	90%	3%	7%
United Arab Emirates	900,000	91%	5%	4%
Yemen	5,930,000	60%	40%	0
South Yemen	1,863,000	90%	1%	9%
Oman	890,000	25%	0	75%

ALL DIAGRAMS BY OMNIGRAPHICS

Site plan for the world's oil jitters. The Middle East is a region of ethnic, political, religious, and economic diversity with a tradition of instability. But the dependence of all OPEC nations on the international oil market and their interaction with industrial and other developing nations have been a source of strength. Now OPEC itself is becoming an influence for moderation and stability in the world oil market.

the Middle East. It is easy to believe that industrial countries are increasingly at the mercy of these oil-exporting countries, whose political and religious traditions are so vital and different from those of the West.

Yet despite these misgivings, there have been few interruptions of supply and no prolonged oil shortages during the last decade; prices have stabilized and even fallen during the past few years. How can we understand this contradiction between our apprehension and reality? How serious is the possibility of future disruptions?

The world oil market has changed significantly in the past decade. There are more buyers and sellers, more international oil companies, and many more national oil companies in both producing and consuming nations. There are more bidders for exploration and development rights and more sources of capital. More producing nations than ever before are engaged in "downstream" operations—refining, distribution, and even retailing.

These changes are the unlikely result of three political and economic forces—strenuous efforts by the producing nations to gain equality with consumers, efforts by everyone to reduce the market's sensitivity to the persistent political instability of the Middle East, and reduced world oil demand, the result of conservation efforts coupled with recession in many industrial countries. But instead of reducing the producers' viability in the marketplace, these changes have combined to give them far more autonomy. A decade ago OPEC did not even decide how much oil it produced—the international oil companies made all the essential decisions. Now OPEC dictates terms to buyers, and some of its members even control the refining, transport, and final destination of their product. The decline in demand owing to recession and more effective conservation efforts cannot alter that basic reality.

These fundamental changes probably will be permanent. A major result has been that producers and consumers are more dependent on each other, with OPEC emerging as the major tool for assuring future stability. But producers and consumers differ in their definitions of stability: buyers want a small surplus of oil while sellers prefer a slight shortfall, and buyers and sellers have very different views of politics, history, and "justice."

Thus, political and economic affairs are interdependent—interventions that have political objectives can be made under economic pretexts, and vice versa. But interventions for whatever purpose can be effective only in a seller's market, in which demand is close to available capacity. Only then can political goals be pursued through oil.

Conflicts Trigger Market Changes

The Middle East, prodigiously rich in oil, harbors five robust, persistent, and interdependent political conflicts that frequently threaten violence. Each has its own implications for the oil market.

The Cold War. Though we think of the Cold War as a confrontation between the United States and the Soviet Union, the fact that the West relies heavily on Middle East oil assures that the East-West conflict will spill over into that region. For example, Iran has been an arena of struggle between the United States and the Soviet Union since before the fall of the shah. Fleet and troop movements have accompanied diplomatic threats, with each side trying to prevent interferences by the other. A more dramatic example of the Soviets' efforts to increase their presence in the area was provided in 1979 by the invasion of Afghanistan.

As early as 1970, the Soviet Union took advantage of Libya's disputes with U.S. companies handling "nationalized" Libyan crude to break the monopoly of Western oil companies and establish a relationship with Libya in this strategic region. The Soviet Union has helped develop oil production in Iraq and has provided arms to countries bordering those with U.S. ties, such as the People's Democratic Republic of Yemen and Ethiopia. In turn, the United States has sought to counter Soviet influence by helping Saudi Arabia arm the Yemen Arab Republic, Somalia, and Pakistan. These activities have clearly contributed to tensions in the Middle East.

The Arab-Israeli Conflict. The most obvious destabilizing influence in the Middle East is the conflict between the Arab states and Israel. The 1973 Arab-Israeli war provided the political catalyst for the OPEC oil embargo of the United States and Holland. This episode was a milestone: OPEC showed it could act as a powerful force on the oil market, and Arab producers found in OPEC a unifying cause around which they could rally. Indeed, many Arabs feel that the 1973 embargo was a landmark demonstration of the power of their oil exploited for both political and economic gain. The Arab states' rhetoric on the issue

PHOTO, PAGES 24-25, BY ROBERT AZZI, WOODFIN, CAMP & ASSOC.

The oil weapon has been more an instrument of psychological than of economic or political pressure.

of a Palestinian homeland has since been stronger than their deeds, but the possibility of effective action should not be ruled out. Indeed, Saudi Arabia has made a solution to the Palestinian issue a major policy goal.

Conflict Among the Producers. Though the Arab-Israeli conflict suggests there is harmony among the Arab states, this is illusory; differences among them are a major factor in oil policy. In the 1950s and 1960s, "reactionary" regimes that supported alliance with the West argued with "revolutionary" regimes that championed national independence and tolerated alignment with the Soviet Union. In the 1970s "accommodationist" states such as Egypt and Jordan cooperated with the United States in seeking a peaceful resolution to the Arab-Israeli conflict, while "rejectionist" states such as Iraq and Libya stood firm in their opposition to Israel.

Both sides encouraged political instability for their own purposes. Egypt was deeply engaged in an apparently hopeless conflict in Yemen in the late 1960s; Jordan expelled Palestinians during the infamous "black September" of 1970. Since the 1950s, Libya has intervened in Tunisia, Malta, Chad, and Uganda, provoked a war with Egypt, and antagonized Saudi Arabia to the point of disrupting diplomatic relations. Iraq invaded Kuwait in the 1960s, cut off oil pipeline exports through Syria and Turkey, and has sparred with Iran since 1975.

Ethnic and Religious Conflicts. Many of these conflicts are based on or sharpened by ethnic and religious differences between and within the producing states. Fundamentalist Islamic religious groups (Shiite) spar with the dominant, more secular Moslem groups (Sunni). Arabs are a minority in Iran and Iranians a minority in Arab countries. In addition, other radical political and religious minorities threaten violence.

These difficulties are exacerbated by the presence, in many countries, of foreign workers in numbers so large as to threaten government authority and to make sabotage an ever-present fear. The dangers are enhanced by minorities inside and outside the country who inflame the conflicts and supply weapons or money to the workers. Indeed, the Iranian revolution began in the oil fields, when workers refused to export crude until the shah left the country. The occupation of the Ka'aba, the Grand Mosque of Mecca, Saudi Arabia, by armed insurgents shortly after the Iranian seizure of the U.S. embassy had a blend of religious, political, and ethnic underpinnings. Both episodes had lives of their own: national authorities were unable to exert effective control.

The oil market is a pawn in these conflicts because for the producers, oil is an essential source of funds for military supplies, food, and social benefits—and hence of government power. Iran and Iraq have heavily damaged each others' oil facilities since 1980, each seeking to reduce the productive capacity of the other and with it the ability to acquire expensive military equipment. As a result, Iraq has practically exhausted its foreign monetary reserves, and Iran has had to slash its oil prices to increase sales and avoid bankruptcy. These conflicts have destroyed the political arrangements put in place by the consuming nations in the 1960s to assure vital petroleum supplies.

Oil Producers and Consumers. Middle East conflicts are aggravated by the fundamental differences in the way oil exporters and importers view the world. The sabre-rattling talk of invading the oil fields in some consuming countries after the oil price increases of the early 1970s was but the tip of the iceberg. Consumers tend to view producers as threatening the security of the industrial world. Producers consider consumers arrogant and even colonialist. This conflict profoundly concerns not only oil but power.

None of these conflicts alone causes the oil market to change, but each influences the actions of both buyers and sellers. Producers exert pressure on their OPEC colleagues by shaving prices, threatening to increase production, interfering with oil pipelines, and spending oil revenues for political purposes.

For example, Iraq stopped delivering oil through Syria to pressure the Syrian government in a dispute over transit tariffs. More recently, Iraq halted its oil deliveries through Turkey because Turkey failed to pay for oil it had taken from the pipeline. Syria has interrupted exports of Iraqi oil through its territory to weaken Iraq in its war against Iran. Saudi Arabia flooded the oil market until Iran, Iraq, and Kuwait gave in to Saudi demands for moderating oil prices. Many observers felt that Saudi Arabia's goal was to weaken Iran and Libya by luring their customers away with cheaper Saudi oil.

Efforts of producers to use oil as a weapon against consuming nations have met with only marginal success. For instance, Iran stopped selling oil to the Philippines to protest repression of Moslem minorities seeking autonomy for the island of Min-

High Stakes for All of Us in the War Between Iran and Iraq

by Cristina A. Haus

VIENNA—OPEC learned a bitter lesson in the summer of 1982: the difficulty of maintaining solidarity among its members in a buyers' market with falling oil prices. OPEC's production controls—a last-ditch effort to defend the official price structure against the onslaught of market forces—are now defunct. They are victims not of economic but of political pressures stemming from the war between Iran and Iraq.

The controls conceived in March 1982 imposed a reduction of 1 million barrels a day on OPEC production, intended to force consuming countries to draw on their reserves. The expectation was that, with stocks drawn down, restocking could increase demand for OPEC oil by the third quarter of 1982.

But OPEC's troubles were not resolved by this strategy, for within a month prices in the spot market had slipped below official levels and were headed down. OPEC's problems were in fact caused by more than the market: internal difficulties had split OPEC into two groups—those who observed official quotas and prices and those who did not. Iran was in fact the principal transgressor, publicly refusing to observe official price and output levels. Iran thus fueled the resentment of other member countries, notably Saudi Arabia and the Gulf states, that had faithfully observed official prices and production quotas at considerable cost to their development plans.

This explosive, delicate matter of good and bad faith led to an extraordinary session of OPEC in July 1982, where a proposal by Venezuela and Indonesia to contain leakages foundered on Iran's intractable demand for an extra allocation to be deducted from that of Saudi Arabia. The idea, said Iran, was to regain its market share allegedly stolen by the Saudis in the confusion following the Iranian revolution. The alignment of member countries on the quota issue mirrored the alliances in the Gulf war: Iran supported by Libya and Algeria, Iraq with the backing of Saudi Arabia and the politically conservative Gulf states.

Three Saudi Options

As OPEC's most important producer and the linchpin of its pricing structure, Saudi Arabia's reaction to these pressures will determine OPEC's course in the months ahead. The Saudis have three alternatives:

☐ *Lower production.* By cutting production under the current quota of 7 million barrels a day, Saudi Arabia would at once demonstrate firm commitment to OPEC's market stabilization plan and resolve its impasse with the radical faction, thus salvaging the quota system for the third and fourth quarters of 1982.

☐ *Reduce official price levels.* In the vacuum created by the collapsed production accord, a Saudi decision to lower prices would destroy the fragile balance within OPEC, triggering a price war, causing irreparable damage to the organization, and prolonging the oil glut into 1983.

☐ *Make no change at all.* If the Saudis maintain the status quo in terms of production and price, other OPEC countries would do the same, all of them waiting for demand to revive as consuming countries move to replenish their depleted inventories. This would solve the oversupply problem and solidify the price structure at least through the end of 1982.

Future OPEC policy will be influenced as much by political issues as by the economic ones implied above. A military setback in Iraq would undermine Iran's power in OPEC decision-making, restoring Saudi Arabia to its usual dominant role. On the other hand, a triumphant war effort would assure Iran a prominent position in OPEC policymaking as a counterweight to the traditional Saudi posture of moderation and self-restraint. This translates into an OPEC less accommodating to the West, more hawkish in its price and production policies. Thus much more is at stake on the Iraqi battlefields than the geopolitical landscape of the Middle East.

CRISTINA A. HAUS, who studied at the Fletcher School of Tufts University, is OPEC correspondent for *Japan Petroleum and Energy Weekly.*

danao in 1979. Iraq stopped selling oil to Canada when Ottawa threatened to move its embassy from Tel Aviv to Jerusalem. Iran suspended deliveries of natural gas to the Soviet Union in 1979, claiming that Soviets had interfered in Iran's internal affairs (but perhaps more significantly protesting the low prices paid by the Soviets). And Libya embargoed oil to Greece for allowing an official Israeli group to visit and for granting asylum to a defecting Libyan pilot.

None of these efforts to use the oil weapon really crippled—or even inconvenienced—the object nation; the effects were mainly psychological.

Exploring the Power of Oil

The oil market has responded to this unique combination of tension and conflict by evolving through seven distinct phases of adjustment, a process especially important for its clues as to what we can expect for the remainder of this decade.

The Awakening. The first effort of oil exporters to take advantage of an Arab-Israeli war to raise prices, in 1967, did not work—the United States then had considerable excess petroleum capacity that it could bring to bear on the oil market, and the Arab countries' market leverage was too small. But the war of October 1973 offered an opportunity that some Arab oil-exporting countries were quick to recognize. By then the U.S. was importing oil, and the balance of power had shifted toward the producers. Other factors were also leading producers to make decisions on price and production they had formerly left in the hands of the major international buyers. Furthermore, the major firms that once dominated the mar-

Even the Iran-Iraq war could not stem the flow of surplus oil. The crisis seemed to disappear.

ket now shared their role with the producing governments and a group of smaller companies.

The Embargo (October 1973 to May 1974). The market had begun to tighten as early as May 1973, signaling the potential for disruption. So when the Arab-Israeli conflict provided a political catalyst, OPEC announced its November oil embargo against the United States and Holland. The embargo was short-lived and incomplete, indicating the frailties of OPEC: Iran (not an Arab state) initiated the price hikes, and Iraq (a radical, often belligerent Arab state) did not honor the embargo. Yet the embargo was a landmark event—for the producers a heady exploration of their newfound power to increase prices, for the consumers a sudden display of OPEC's power to interrupt supplies and raise prices. For the first time, some producers voluntarily slowed production in the name of a political objective, and the West found itself vulnerable. OPEC and the industrial nations recognized themselves as antagonists.

The Recession (June 1974 to October 1975). Production quickly returned to normal levels after 1973. But prices had been ratcheted upward fourfold. In consuming countries, concern for supplies was replaced by economic woes: domestic inflation and balance-of-payments crises. Many of the industrial nations responded with policies designed to constrain economic activity in order to reduce consumption and curb inflation, and there was increasing emphasis on conservation and fuel substitution. As a result, oil consumption and energy use as a percentage of gross national product began to decrease—and have continued to do so ever since. Meanwhile, inflation pushed upward the price of manufactured exports to OPEC at the same time reduced sales pushed downward on oil revenues, and there was modest pressure within OPEC for new price increases. OPEC briefly sought to maintain cohesion in the face of this pressure by recognizing a dual price structure (the so-called "Doha agreement"), but official prices soon stabilized and even declined slightly.

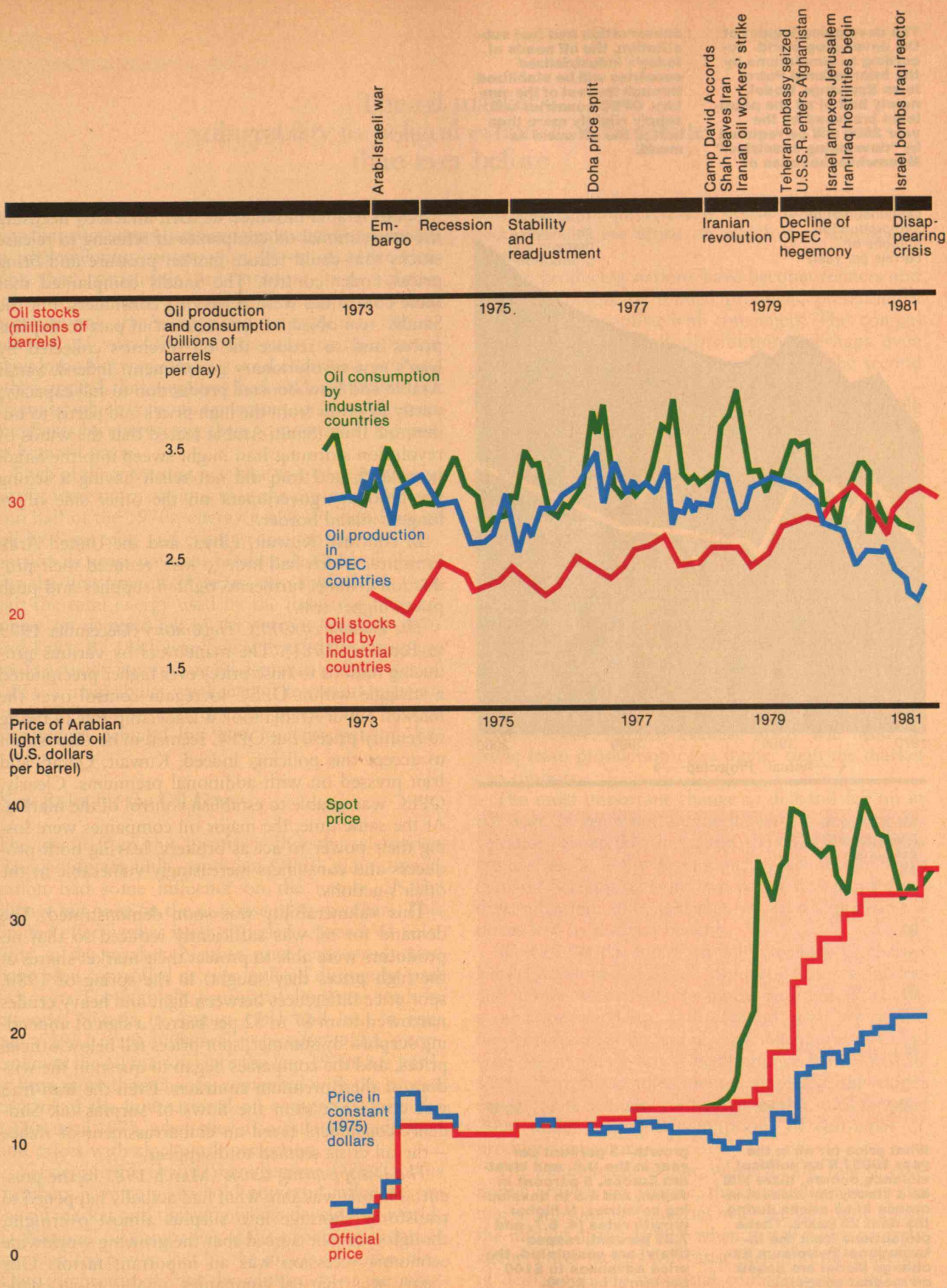
Stability and Readjustment (November 1975 to October 1978). The next three years were relatively stable. Oil consumption leveled off after decades of exponential growth. Oil stocks behaved normally. Through insight or accident, OPEC production corresponded with the needs of the seven largest consuming nations. All the players appeared satisfied.

But this placidity was deceptive, for there was hardly even a facade of cohesion among the producers. Saudi Arabia, Iran, and Iraq played out a three-way rivalry in the oil market. Saudi Arabia and the United Arab Emirates refused to raise prices on the grounds that conservation had reduced demand and the market was saturated. But the Saudis may have also wished to constrain Iran's ability to pay for foreign arms purchases. Meanwhile, Iraq increased its output to finance arms purchases. Everyone in the region had begun to acquire arms on a very large scale, beyond any previous level, for every cause and from every supplier. The suppliers in turn encouraged this brisk trade, for their sales of arms went a long way toward offsetting their rising oil bills.

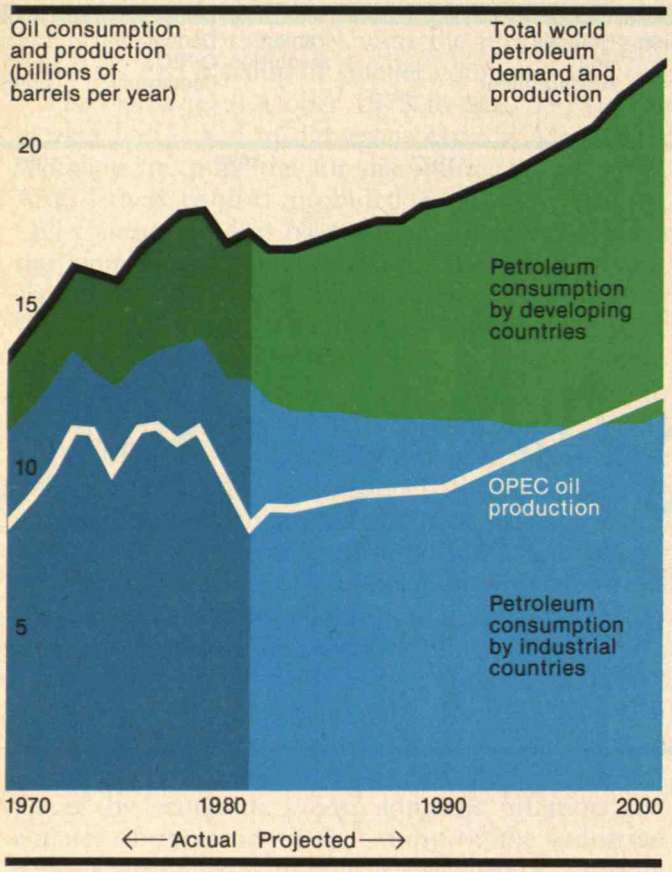
The Iranian Revolution (November 1978 to November 1979). The connection between political instability and the oil market has nowhere been better demonstrated than in the Iranian revolution of 1978-79. In November 1978 oil workers in the Abadan region refused to export oil unless the shah left Iran, and they made good their threat: within one week Iranian oil production fell by half. The United States, incredulous that the Western presence could so easily be shaken, pressured the shah to leave, partly to ensure that oil would flow and partly to improve its position with the new government. When he did, the new government seized the initiative by announcing a production ceiling of 4 million barrels a day, 2.7 million fewer than before the revolution.

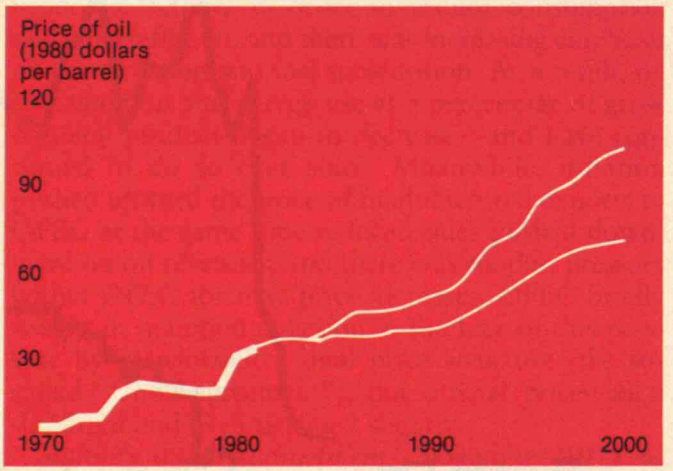
The shortfall was not severe, but the psychological effect on the market was profound. Major oil companies canceled sales contracts and began stockpiling supplies as a hedge against the spread of revolution. Spot prices tripled within three months, and OPEC increased its prices ahead of schedule. Sellers found they would be paid practically any price they asked, surcharges became a way of life, and many producers imposed restrictions on the transport and destination of their oil.

A decade of change in the world oil market. Top: after the first "crisis" in 1973, oil production, stockpiles, and consumption maintained a fairly constant relationship until 1978, when demand in the industrialized nations suddenly turned down. Though OPEC production also decreased, stockpiles were higher than ever before—and continued to build through 1981. Now the market is stabilizing again in a new era of reduced production. Meanwhile, when the Iranian oil workers struck in late 1978—the first act of the Iranian revolution—the consuming nations' fears of shortages and economic chaos led to sharp increases in prices on the spot market (below). But there was no basis for panic because of large stockpiles in the consuming nations and continued high production by OPEC.


Arab-Israeli war
Doha price split
Camp David Accords
Shah leaves Iran
Iranian oil workers' strike
Teheran embassy seized
U.S.S.R. enters Afghanistan
Israel annexes Jerusalem
Iran-Iraq hostilities begin
Israel bombs Iraqi reactor
Em-bargo
Recession
Stability and readjustment
Iranian revolution
Decline of OPEC hegemony
Disap-pearing crisis
Oil stocks (millions of barrels)
Oil production and consumption (billions of barrels per day)
1973
1975
1977
1979
1981
Oil consumption by industrial countries
3.5
30
Oil production in OPEC countries
2.5
20
Oil stocks held by industrial countries
1.5
Price of Arabian light crude oil (U.S. dollars per barrel)
1973
1975
1977
1979
1981
40
Spot price
30
20
Price in constant (1975) dollars
10
Official price
0

The developing impact of the developing world. According to simulations by the International Petroleum Exchange Model, nearly half of all the petroleum produced by the year 2000 will be required by "developing countries." Meanwhile, because of conservation and fuel substitution, the oil needs of today's industrialized countries will be stabilized through the rest of the century. OPEC countries will supply slightly more than half of the oil world demand.





What price for oil in the year 2000? If no political violance occurs, there will be a steady but modest increase in oil prices during the next 20 years. These projections from the International Petroleum Exchange Model are based on modest economic growth—3 percent per year in the U.S. and Western Europe, 5 percent in Japan, and 5.5 in developing countries. If higher growth rates (4, 6.7, and 7.25 percent, respectively) are postulated, the price advances to $100 per barrel by 2000.

Saudi Arabia mounted its own attack by accusing the international oil companies of refusing to release stocks that could reduce market pressure and bring prices under control. The Saudis complained that these companies were penalizing consumers, but the Saudis' real objective was at least in part to depress prices and so reduce the oil revenues collected by Iran's new revolutionary government. Indeed, Saudi Arabia and Iraw boosted production to full capacity, partly to profit from the high prices and partly to undermine Iran. (Saudi Arabia feared that the winds of revolution storming Iran might sweep into the Saudi homeland, and Iraq did not relish having a strong revolutionary government on the other side of its longest inland border.)

In contrast, Kuwait, Libya, and the United Arab Emirates, which had little to lose, reduced their production ceilings further to tighten supplies and push prices higher still.

The Decline of OPEC Hegemony (December 1979 to February 1981). The maneuvers by various producing nations to raise prices ever higher precipitated a struggle within OPEC to regain control over the market. Saudi Arabia took a leadership role in trying to reunify prices, but OPEC seemed in no disposition to accept this policing. Indeed, Kuwait, Qatar, and Iran pressed on with additional premiums. Clearly, OPEC was unable to establish control of the market. At the same time, the major oil companies were losing their power to act as brokers, leaving both producers and consumers increasingly vulnerable to the other's actions.

This vulunerability was soon demonstrated. The demand for oil was sufficiently reduced so that no producers were able to protect their market shares at the high prices they sought. In the spring of 1980, spot price differences between light and heavy crudes narrowed from $7 to $2 per barrel, a sign of impending surplus. By summer, spot prices fell below official prices, and the companies began to question the wisdom of their premium contracts. Even the Iran-Iraq war could not stem the flows of surplus oil. Suddenly consumers faced an embarrassment of riches —the oil crisis seemed to disappear.

The Disappearing Crisis (March 1981 to the present). No one was sure what had actually happened to transform shortage into surplus almost overnight, though everyone agreed that the growing worldwide economic recession was an important factor. One theory was that oil companies, unable to stockpile

The oil market's vulnerability to political events is now greater than ever before.

more oil, began to release their supplies. Still another was that consumers had been unexpectedly successful in implementing conservation efforts. Another view was that consumers' investments in petroleum substitutes—such as coal and renewables—had begun to pay off. Another tied the surplus to the expansion of non-OPEC production in the United Kingdom, Norway, Mexico, and elsewhere. Still another argued that suppliers had underestimated the extent to which consuming nations could reduce their purchases by contracting their economies in response to high oil prices.

Each of these theories was true to some extent. The results were more obvious than the causes: in the second half of the 1970s, energy use in Western Europe fell by 8 percent, and energy consumption as a proportion of gross national product declined similarly. For the first time in 25 years, oil supplied less than half the total energy used by the industrial nations, where oil demand fell by 18 percent between 1979 and 1981. By 1981 everyone realized that consumers could actually manipulate oil demand, and the idea of OPEC's invincibility weakened. The crucial question for OPEC and for everyone else became not how to manipulate demand but how to anticipate its behavior.

New Rules for the Oil Game

The lesson from this history is that the oil market changed significantly—and that OPEC as an organization had some influence on the nature of that change but none on the response of its members. This limited effectiveness itself provided a source of volatility in the market. Neither prices nor production have been controlled or even policed during the past five years. For example, because of desperate needs for revenue, Nigeria in August 1981 and Iran in February 1982 made unilateral price cuts. OPEC's control over the oil market since the late 1970s has hardly been more than chaotic compared with the precise control of the international oil companies from the 1930s until 1973, when they manipulated production and prices with clockwork perfection.

Yet despite this chaotic management, OPEC and its members have come to hold powerful influences on the oil market and throughout the developing world:

- ☐ National oil companies of the exporting countries assumed the power lost by the major oil companies. Thus the producers, not the consumers or the international oil companies, now decide how much oil is produced and the terms on which it is supplied to consumers.
- ☐ The producing nations have become refiners and even distributors of refined products, presenting a new arena for conflict with consumers. This competition in refining and distribution—perhaps even retailing—will be the game to watch in the second half of the 1980s.
- ☐ Through OPEC, the producers give all developing countries a model for exerting economic and political pressure on industrial countries through the control of critical resources. The success of the effort is less important than the attempt itself.

Producers Become Consumers

The behavior of the oil market for the rest of this century depends on the stability of the major producing nations. There will be more actors in the oil market (more countries and companies) and greater diversity among both sellers and buyers than ever before. Capacity will go unused throughout OPEC—and competition and perhaps even conflict will occur among OPEC nations because many will need income from production rates higher than the market can support.

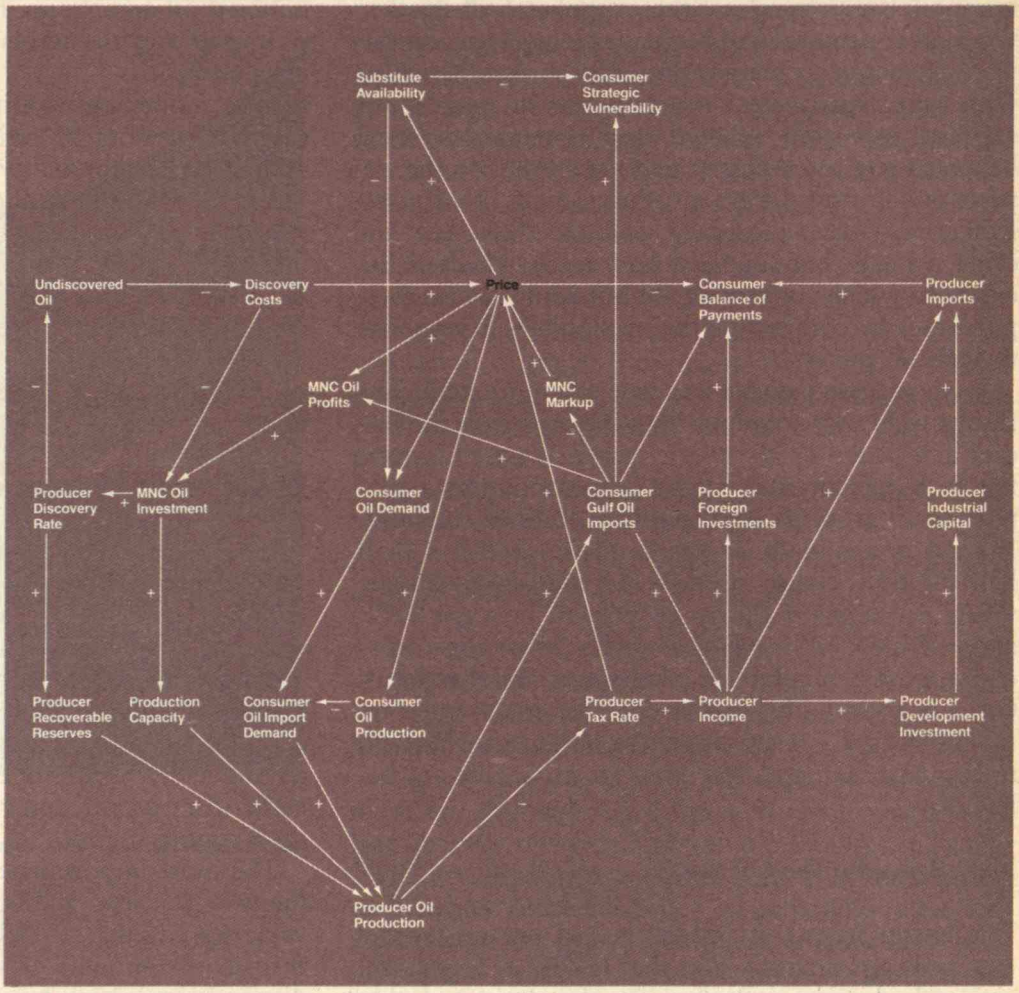
The most important change in demand for oil in the next 20 years will be the increasing needs of developing countries—including the OPEC countries themselves. In many developing regions this growing demand is resulting from two policies: expanded industrialization, and subsidies to keep domestic oil prices low as a social benefit.

We can use the International Petroleum Exchange Model developed at M.I.T. to forecast oil production and prices. We provide the model with initial data on production capacity and demand and verify the model's accuracy by comparing the figures it yields with the market's actual performance from 1970 to 1980. With these adjustments completed, the model can simulate how the market will evolve until the year 2000 under different assumptions of consumer or producer behavior.

The major result is that, whatever the rate of economic growth we assume, the demand for oil in the major consuming countries will decline until about the middle of the 1990s, when it will begin to grow again. Three factors will cause this continuing decline in demand in the industrial countries: slowing eco-

OPEC's ineffectiveness has been a source of volatility: neither prices nor production have been controlled.

How everything affects everything in determining the price of oil. The author's International Petroleum Exchange Model is designed to represent the dynamic behavior of the world oil market. For example, price forecasts are based on production cost, policies of major oil companies (MNCs) and supply and demand in both producing and consuming nations. Time lags represent periods for market adjustments. Non-OPEC supplies play an important role over the long-term, while OPEC influences the shorter-term dynamics.



nomic growth compared to that in the 1960s, continuing conservation measures, and greater use of other energy sources. But demand for oil will grow rapidly in the developing world between now and the year 2000.

The simulations show that OPEC will respond by gradually increasing production until 2000, with supplies adequate into the twenty-first century. But if the developing countries continue to industrialize while subsidizing domestic oil prices, demand may well exceed production, with the market tightening once again by 1990 to 1995.

Determining future oil prices is more difficult, but the model suggests no precipitous collapse of the OPEC price structure in the 1980s. What happens to prices depends on the producers: whether they curtail production or continue to meet—or exceed—demand. Prices are already stiffening, and growing demand may lead to gradual price increases before 1990. The rate of increase will steepen in the 1990s, principally because demand will increase sharply in the developing countries, with oil reaching $70 per barrel (1980 dollars) by the year 2000 (*see the chart on page 32*). Higher economic growth rates, especially in the developing countries, could take the price to as much as $95 per barrel.

Tinder Awaiting a Match

These forecasts do not include the possibility that political conflicts in the Middle East could disrupt the market. Such changes could in fact transform the oil market overnight and plunge customers into serious economic and perhaps political crisis. As we pointed out, the market's vulnerability to political events has increased since the 1970s. The reduced role of the

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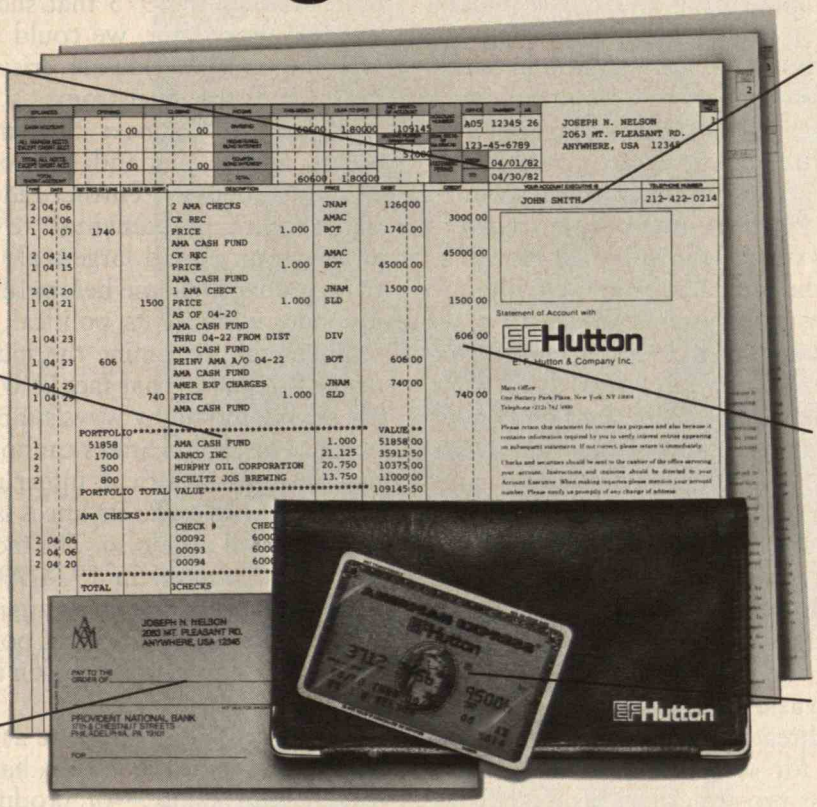

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Having learned the lessons of the 1970s, OPEC may become a force for stability and restraint in the 1980s.

major oil companies means that market give-and-take between consumer and producer will be more difficult in the future. There will be greater competition, more diversified political power, and more market volatility; even the *threat* of a significant disruption could affect prices.

Ethnic conflicts are the most obvious source of such disruption; indeed, ethnic differences in the Middle East are now like tinder awaiting a match. The domino theory is on fertile ground in this region: the rapidity with which the Mecca rebellion in Saudi Arabia and the civil disturbances in Kuwait followed the Iranian seizure of the U.S. embassy in 1979 is grim evidence of how one political event can lead to others. Such disorders are less likely to affect production than distribution. Pipelines are extremely vulnerable, and choke points such as the Straits of Hormuz, Bab el Mandeb, and the Suez Canal are equally unprotected. Other transport systems are almost as pregnable: at one point late in 1978, a handful of Iranian tugboat pilots actually prevented Iran from exporting any oil for about one week. Iraq and Saudi Arabia have been trying to expand pipelines to diversify export networks, but the effort is modest compared with what needs to be done if supplies are to be protected from disruption.

Threats against oil fields could be an effective way for dissidents to pressure governments to support their causes. Perhaps the most difficult conflict is between the Arab states and Israel, a tension much inflamed by Israel's invasion of Lebanon. President Qadhafi of Libya has threatened to make the oil fields the arena, by proxy, for conflict with Israel. Even Saudi Arabia, the most pro-American producer, has explicitly linked continued high production levels to progress toward a "just" solution to the Palestinian dilemma.

The Cold War also continues to hover over the Middle East. This is not to say that the Soviets might invade Iran or any other Middle East country, or that the United States might. The Soviet move into Afghanistan was an "invasion by invitation," not much different from the U.S. military presence in many Persian Gulf states. The real danger lies in miscalculations and overreactions, or both. The sheer magnitude of military resources in the Indian Ocean and the Gulf makes the situation dangerous, and the ethnic and religious differences magnify the danger. Indeed, it will be miraculous if there is no major violence in the next 20 years.

The possible worldwide impact of any disruption or overt conflict in the Middle East depends critically on timing. The West was lucky that the most dramatic political change in the region since 1973—the Iran revolution—came at a time of relatively high oil stockpiles and downward adjustments in demand. For the same reason, the war between Iran and Iraq has hardly been felt by the market. Had the United States known in 1973 that such a war would break out five years later, we could hardly have predicted anything but worldwide crisis with many nations drawn into the maelstrom.

At least for the next 20 years, most of the adjustments on the demand side of the oil market are already underway. Further reductions in oil demand will require fundamental advances in alternative energy sources and large-scale conservation projects that can hardly come before the year 2000. The supply side, with all its political and economic uncertainties, will determine the market situation for the next 20 years. In that fact lie U.S. frustrations—there are simply too many ways supply interruptions could occur. The United States cannot afford complacency: just because political interruptions have not yet brought the West to its knees is no reason to assume that they will not do so. The fact that OPEC lost control of the market in 1978-79 is reason enough to suggest that it might do so again. On the other hand, OPEC clearly has powerful policy instruments at its disposal and there is no reason to expect reluctance in utilizing them.

But there is a very hopeful aspect to OPEC's recent experience. For the 1970s have been a decade of learning for OPEC—of producers finding ways to work together despite political and social conflicts and of OPEC as an organization establishing a measure of confidence and authority in the world oil market. Two facts—that OPEC is surviving a war between two of its prominent members, Iraq and Iran, and that the West is unable to completely control its major ally in OPEC, Saudi Arabia—are testimony to OPEC's success. Having learned these lessons, OPEC may become an increasingly effective force for stability and restraint, at least for the rest of this century.

NAZLI CHOUCRI, professor of political science at M.I.T., was educated at American University in Cairo, and Stanford. Her research has been in international conflict, public policy, and energy resources, especially in developing countries. Her latest book is *Energy and Development in Latin America: Perspectives for Public Policy* (D.C. Heath, 1982).

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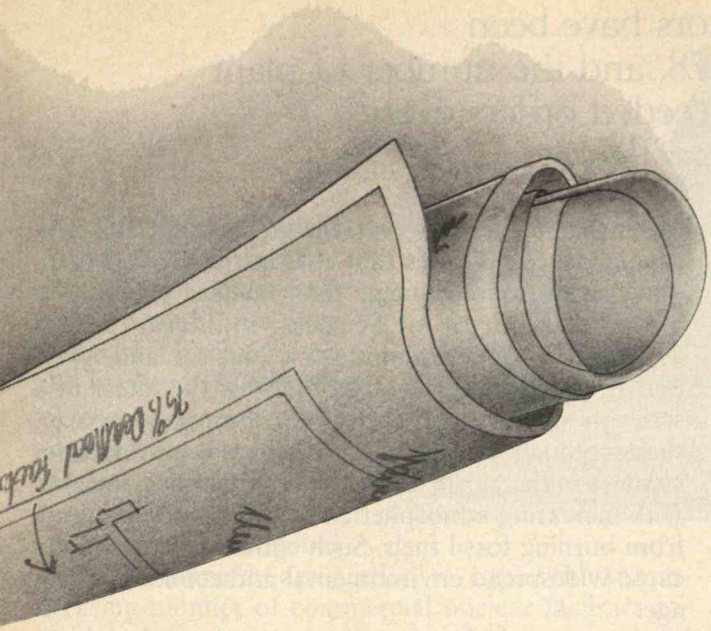


Is the Nuclear Industry Worth Saving?

BY RICHARD K. LESTER

Yes, but the outlook is bleak. Neither utilities nor the government seems willing to take the tough steps needed—though developing a new generation of reactors offers some hope.

In the United States 72 nuclear power plants produce electricity commercially, with a combined capacity of approximately 55,000 megawatts. These plants generated about 12 percent of the U.S. electricity supply in 1981. Another 72 reactors—with about 78,500 megawatts of capacity—are at various stages of construction, and 17 more reactors are on order but have not yet received federal construction permits.

However, no new reactors have been ordered since the end of 1978, and the number of plant cancellations has exceeded orders in every year since 1975. Twenty-two plants have been canceled in the last two years alone, and more cancellations are expected in the next few years, including several plants well along in construction. A prudent upper estimate for commercial nuclear capacity by the early 1990s is 120,000 megawatts—about 20 percent of total electricity supply at that time, but only half the amount that utilities had planned before the nuclear recession began in 1975.

Why should these figures, which provide a graphic image of a declining industry, be of more than passing concern to anyone outside the industry itself? After all, market forces seem to have given a vote of no-confidence to civil nuclear technology. And the industry, though sizable, is not so large that its demise would seriously disrupt the national economy. Some small firms that specialize in making nuclear components would certainly be forced out of business, but the four large U.S. companies that manufacture reactors would survive. Even Westinghouse, the most heavily committed, is reported to depend on its nuclear business for no more than about 15 percent of its earnings. In any event, the economic impact of the industry's collapse would occur gradually: breathing space would be provided by reactor construction backlogs; service contracts, modifications, and fuel orders for operating reactors; and the occasional export order. Pragmatists might also argue that if more nuclear power plants are needed in the future, the industry could be reconstructed from the kernel of

ILLUSTRATIONS: IRENA ROMAN

No new reactors have been ordered since the end of 1978, and the number of plant cancellations has exceeded orders every year since 1975.

manufacturing capabilities and trained personnel preserved in the military nuclear programs.

Such reasoning is incomplete in several important respects, however. First, most authorities agree that demand for electricity will continue to grow, and utilities will have to build new generating plants both to meet this new demand and to replace worn-out plants. Although energy conservation and the sluggish economy have cut the annual rate of electricity demand growth from its pre-1973 level of 7 percent to an average of 2.6 percent since then, overall energy use is becoming more electricity-intensive. During the last eight years, while nonelectrical energy consumption declined by 10 percent, electricity demand grew by 23 percent.

The Department of Energy recently projected that peak electricity demand over the next decade will grow at an average of 3.2 percent per year, and the National Electric Reliability Council estimated that it will grow 3.4 percent per year. Past official forecasts have usually overestimated actual demand growth. But even assuming a lower growth rate, the electric utilities will soon have to add to the 180,000 megawatts of new generating capacity that they are already committed to build. For example, if demand grows at 1.5 percent per year and the plant replacement rate is 1 percent per year, an additional 100,000 megawatts of capacity will be needed by the year 2000.

Central-station baseload plants will provide most of this capacity, despite the growing role of smaller-scale technologies such as wind power, cogeneration, and solar electric systems. And nuclear power continues to be significantly cheaper than coal—its only real competitor in this application—in most regions of the country. Nuclear plants entering service during the next two or three years should on average produce electricity costing at least 10 percent less than that from coal-fired plants throughout the East, the Great Lakes and Pacific states, and in much of the South. Only in the northern mountain states would coal-based electricity be cheaper. Over the longer run, the uncertainties are so great that cost comparisons cannot be made with confidence. But it's clear that the decrease in competition arising from a decision not to exploit either energy source would significantly increase the cost of the other.

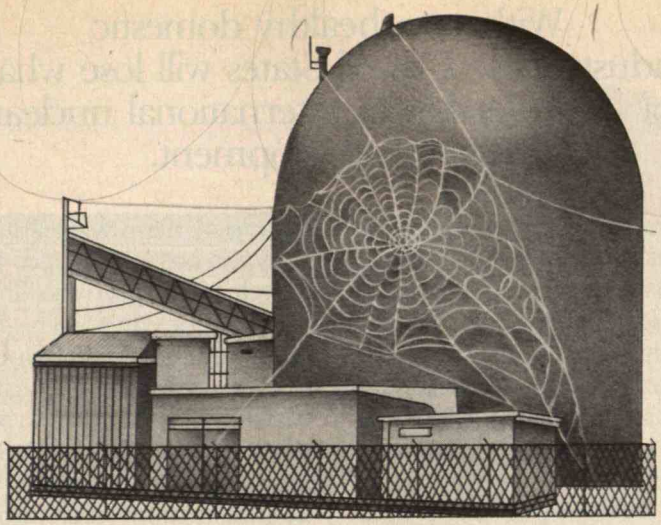
Safety concerns favor preserving the nuclear option, too. Both coal and nuclear power inevitably have adverse effects on public health and safety and the environment. However, the great weight of scientific evidence indicates that coal-burning plants generally cause more damage than nuclear plants. The National Academy of Sciences' multiyear project conducted by the Committee on Nuclear and Alternative Energy Systems (CONAES) is the latest in a series of studies to reach this conclusion. Moreover, these comparisons usually do not take into account changes in the world's climate that may be associated with increasing atmospheric carbon dioxide resulting from burning fossil fuels. Such climatic change could cause widespread environmental and economic damage.

A continuing deterioration in the outlook for nuclear energy may also cause trouble for existing nuclear plants. As engineers switch to more promising fields, the knowledge base of nuclear engineering will inevitably erode. Some of the nation's leading universities have already experienced a serious decline in the interest of U.S. students in nuclear-fission applications. (The number of foreign students has increased to 50 percent or more in some cases.) Even though defense nuclear programs will provide some continuity, if such trends continue it may become increasingly difficult to maintain the technical standards necessary for operating nuclear plants safely, reliably, and economically.

World View

Without a healthy domestic nuclear industry, the United States will lose what remains of its leadership in international nuclear energy development. The industry's primary concern, of course, is to avoid losing ground to competitors in the world marketplace. But there are more fundamental questions at stake. The weakening of the U.S. position will add to the difficulty of preventing worldwide nuclear energy development from contributing to the spread of nuclear weapons. Leadership in nuclear export markets is now passing to the "middle" powers of Western Europe and perhaps soon to Japan—nations with global economic interests but largely regional security concerns.

The trend toward a more pluralistic nuclear industrial structure was inevitable, and was foreseen by the architects of the Treaty on the Nonproliferation of Nuclear Weapons and the nuclear safeguards system administered by the International Atomic Energy Agency. What they did not foresee was that the



United States would withdraw from the front rank of civil nuclear nations and hence lose much of its influence on the further development of the nonproliferation regime. Moreover, this transition is taking place just when stronger controls on international nuclear commerce are needed to cope with the increasing number of commercial nuclear facilities capable of producing highly enriched uranium and plutonium and the larger quantities of these materials entering circulation. Of course, American participation in international nuclear trade will not guarantee nonproliferation, and in some instances may actually contribute to the problem. But nuclear trade will continue, whatever the fate of the American nuclear industry, and of all the Western industrialized nations only the United States can bring a global security perspective to bear on the further development of nonproliferation controls. On balance, an American withdrawal from the industrial scene is likely to create more problems for world nonproliferation efforts than it solves.

Hesitation in U.S. nuclear policies is also slowing the civil nuclear programs of many other Western industrialized nations, whose energy alternatives are usually fewer and whose need for nuclear power is greater. Foreign public opinion and policy regarding nuclear power continue to be strongly influenced by political, industrial, and regulatory developments in the United States, whose earlier role as an enthusiastic promoter and supplier of nuclear technology is still remembered. In Japan, for example, much will depend on the skill with which its leaders can dissociate the Japanese nuclear program from the American nuclear crisis without simultaneously appearing to disown the technology that both countries share. (One argument offered is the claim that Japanese nuclear workmanship and operating practices are superior.) Even the French—zealous custodians of their nuclear independence and the only Western nation able to sustain a steady rate of nuclear growth—privately express concern on this score.

The role of nuclear power in reducing energy vulnerability has often been exaggerated, in Europe and Japan as well as the United States. Yet it is surely the case that any delay in curbing energy costs, and especially in limiting oil imports, threatens not only the country involved but also the cohesion of the Western alliance and, ultimately, U.S. security. Of course, the difficulties facing nuclear programs overseas cannot be attributed primarily to the moribund state of the American program, nor do I argue that American domestic nuclear policy should be dictated by the presumed needs of other governments for political support in the nuclear field. Nevertheless, U.S. energy policies—nuclear and nonnuclear—are linked to its international responsibilities as the political leader of the Western alliance, and this link is much less clearly understood here than abroad.

The Bottom Line

General arguments such as these are all very well, but the view from the boardrooms of U.S. electric utilities—where decisions on whether to proceed with nuclear power are ultimately made—is quite different. For utility investors, the present risks of new investments in nuclear plants decisively outweigh the potential economic benefits.

This is partly a result of general disincentives to invest in new generating plants of any kind. Many utilities already have substantial overcapacity. At the same time, persistent inflation, unprecedentedly high interest rates, and delays by state regulatory agencies in granting rate increases have combined to prevent most utilities from earning a reasonable return on investment in recent years. Indeed, the precarious financial condition of the electric utility industry is now a matter of national concern.

But this has not prevented utilities from ordering 24,000 megawatts of coal-fired plant capacity during the last three years while ordering no nuclear plants at all. This bias is partly due to the higher capital costs of nuclear plants. Utility executives see the large savings in fuel costs that will be provided decades hence by nuclear power as being more than offset by the short-term difficulty of obtaining the extra capital needed to build a nuclear plant. Moreover, nuclear-plant construction costs have risen dramatically dur-

Without a healthy domestic nuclear industry, the United States will lose what remains of its leadership in international nuclear energy development.

ing the last decade, and several plants have experienced massive cost overruns. Inflation has been a major factor. But deficiencies in project management and quality-assurance practices, as well as the increase in and unpredictability of regulatory requirements, have seriously exacerbated the problem. There has also been a rapid increase in the lead times for constructing nuclear plants: 12 to 14 years now typically elapse between initiating and completing a nuclear project—well beyond the horizon of reliable utility forecasts. These recent trends suggest that the current cost advantage of nuclear over coal may be eliminated, perhaps even reversed, before any plant ordered now could be brought on line. And with General Public Utilities, the owner of the crippled reactor at Three Mile Island, still facing possible bankruptcy, utility executives remain acutely aware that a nuclear plant taking years to build and costing several billion dollars could be suddenly and indefinitely incapacitated.

There is also continuing uncertainty regarding the management of radioactive spent-fuel assemblies. A 1,000-megawatt reactor discharges about 30 tons of spent fuel per year, which is now stored in pools at reactor sites. Almost 10,000 tons have accumulated nationwide, and the total will probably be at least six times larger by the end of the century. Interim storage capacity at reactor sites is limited, yet there are no firm plans for removing the spent fuel. Many in the nuclear industry hope eventually to recover and recycle the plutonium and residual uranium in the fuel. But reprocessing is not now economical, and opinions differ as to when, or even whether, it will become attractive commercially.

Whether or not reprocessing takes place, nuclear wastes—in the form of unreprocessed spent fuel or highly radioactive liquids generated during reprocessing and then solidified—must eventually be disposed of permanently. The federal government is legally responsible for this task, and the method currently preferred is underground disposal in deep repositories located at carefully selected geological sites. Though the technical prognosis for underground disposal is good, the government's previous waste-management efforts have been unimpressive and doubts persist about its ability to provide suitable repositories when required. (*See "The Technology of Nuclear Waste Management," by Rustum Roy, April, 1981, pp. 38-50.*) In fact, several states have prohibited nuclear plant construction until satisfactory progress in disposing of these wastes has been demonstrated.

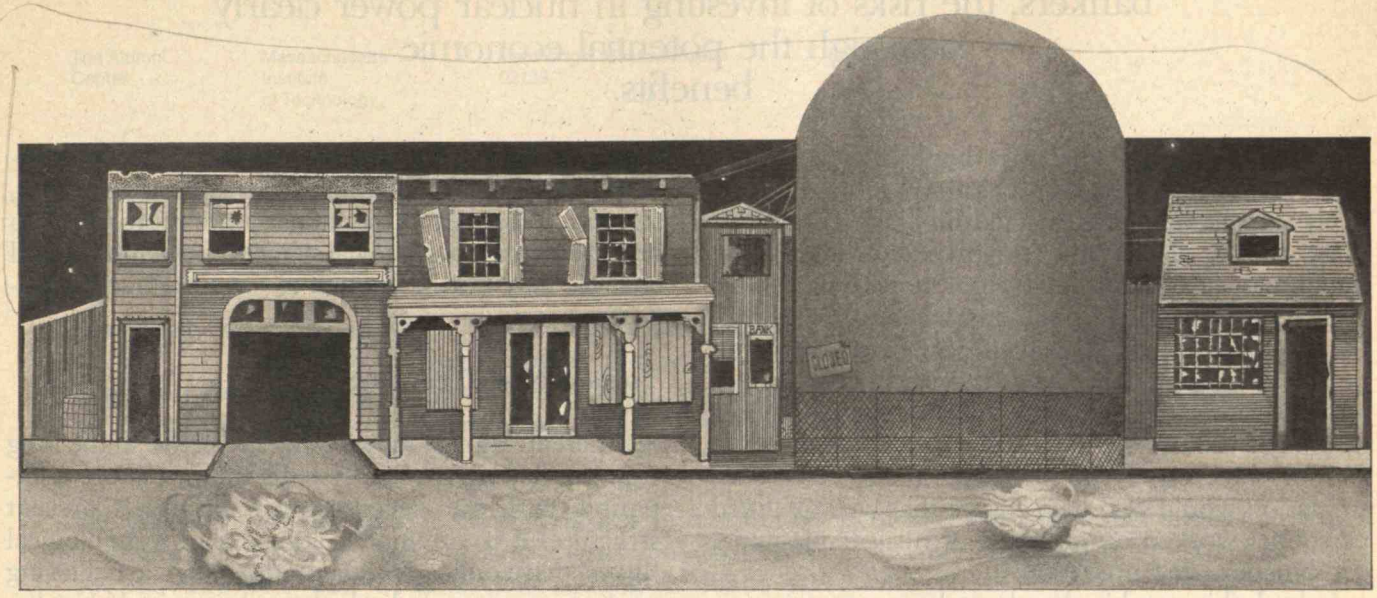
What has developed, then, is a fundamental mismatch of perspectives. There is the "national interest" view of nuclear power—that it is important economically and politically to complete most or all of the plants now under construction and to retain the capability to build new plants beginning, perhaps, in the early 1990s. The Reagan administration has adopted this view, as for the most part did the Carter administration (even though political concerns and internal disagreements prompted it to label nuclear power the energy option "of last resort"). On the other hand, there is the utility view: nuclear power is now too risky an investment and seems likely to remain so for the foreseeable future.

How might this divergence of views be reduced? What changes in the electric-power industry are needed if nuclear energy is to become a viable option? How should responsibility for making the changes be distributed among government authorities and private industry? How might the federal government improve the utility industry's assessment of its ability to finance, construct, and operate nuclear plants safely and reliably? The answers will in effect determine whether the nuclear industry is worth saving, since they define the costs of doing so. Yet the questions are not being realistically addressed by either government or the industry.

The Government Side

The Reagan administration's nuclear policies seem to rest on the idea that the government's primary contribution will be to streamline the regulatory process. This approach is, of course, consistent with the president's goal of returning to the era of smaller government, when private enterprise, unshackled by excessive regulation, could apply its resourcefulness and ingenuity to the challenge of the marketplace.

For the nuclear industry, however, this vision is not historically accurate. What preceded the recent era of burdensome regulation was an era of activist government promotion of nuclear power, so the Reagan "hands-off" recipe for revitalization would actually be a radical experiment. The regulatory process certainly can be made more efficient and effective. Standardizing reactor design and "banking" potential power-plant sites are two improvements now receiving attention, as is the general goal of improving the Nuclear Regulatory Commission's performance. But



the history of the nuclear-energy industry suggests a basic contradiction between the administration's pronuclear rhetoric and its ideological convictions regarding the limits of government intervention.

As if expressing some internal doubts that its laissez faire approach will succeed, the administration has proposed several more interventionist steps. For example, not only has President Carter's ban on commercial spent-fuel reprocessing been reversed, but the administration has actively sought to create a reprocessing industry in the private sector. The fact is, however, that there is nothing resembling commercial demand for the plutonium that would be recovered. The "market" suggested by the government appears to be based on the plutonium requirements of the breeder-reactor development program, which are not large enough to sustain a commercial reprocessing industry, and also on an ill-starred proposal to use the plutonium in the nuclear weapons program. This latter proposal has apparently been discarded after a flurry of protest. The only possible commercial role for plutonium during the next few decades—recycling it as fuel for conventional light-water reactors—is very unlikely to be economical until after the turn of the century, if then.

The administration's optimism regarding early reprocessing has added to its reluctance to intervene in the problem of spent-fuel storage. If left to the financially troubled utilities, most of the spent fuel will remain stored at the reactor sites, since this will be the simplest and cheapest solution. But in the long run, it will prove a very poor solution. Some reactors may eventually be forced to shut down because they lack storage capacity. Even more important, if utilities decide to resume ordering new nuclear plants during the 1990s, the presence of several hundred tons of spent fuel at each existing site is likely to deter approval of new ones.

Therefore, one or more large centralized facilities for extended interim storage of spent fuel must be provided. This will require some form of government help, such as joint public-private financing or a storage site on federal land. Opponents of federal participation will argue that this would be an unjustifiable "bail-out" of the utilities. But this overlooks the longer-term benefits to the nation in keeping the nuclear energy option open—benefits that would not motivate private investors because they couldn't be fully converted into financial returns.

The Industry Side

Ironically, the utility industry's own structure may also impede nuclear recovery. In retrospect, the original strategy for commercializing nuclear power was seriously flawed in its assumption that complex nuclear reactor systems could be deployed throughout the utility industry just as fossil-fuel plants had been. In practice, some utilities have done a competent job in designing, constructing, and operating nuclear plants, but overall the industry has not achieved the consistently excellent performance that the technology requires. This uneven performance has focused attention on the idea that radical institutional changes within the utility industry are a prerequisite for new nuclear commitments.

One suggestion is to think big. This argument holds that the organizations responsible for financing, constructing, and operating nuclear plants should be fewer in number and larger than today's

For utility stockholders and bankers, the risks of investing in nuclear power clearly outweigh the potential economic benefits.

utilities. They could therefore better afford to buy new reactors, since each purchase would have a relatively smaller and more manageable financial impact. (Two-thirds of the investor-owned utilities now building nuclear plants have more than 30 percent of their total assets tied up in construction; for several, the number exceeds 50 percent.) The reactors could be clustered at remote "nuclear parks" where safety and environmental damage would be minimal. (Most of today's utilities are too small to acquire more than two or three big 1,000-megawatt units.) This consolidation would also help ensure that well-qualified personnel worked on all levels of nuclear planning, construction, and operation.

Indeed, this trend is already underway to some extent. For example, utilities that originally intended to go it alone are increasingly entering into joint ventures with neighboring power companies to complete existing nuclear construction projects. And on a grander scale, several proposals have recently been made to consolidate nuclear plants—or perhaps all central-station power plants—into just a few regional entities or even a single national entity. Such ventures could be owned publicly or privately, or by some combination that provides the best features of each. The generation of electricity could be separated from its transmission and distribution to consumers, thereby encouraging competition among generators since transmission-line operators could buy power from the cheapest supplier. (Today, all operations from generation to distribution are usually carried out by the same utility.) Some proposals would also transfer the rate-setting authority from the states to regional or federal regulatory agencies, since many in the utility industry see "unsympathetic" state agencies as the primary obstacle to restoring its financial health.

However, if the future of nuclear energy depends on such wide-ranging institutional reforms, then the prognosis is bleak. In addition to the practical problems of implementing such vast changes, the result—a more centralized utility industry and a redistribution of regulatory authority away from the states and toward the federal government—runs counter to present political trends. The nuclear crisis alone is almost certainly not of sufficient magnitude to provoke these changes. Indeed, it is only because of the precarious outlook of the entire utility industry that they are being considered—and even then, the industry's dire financial situation has yet to generate much political support for major reforms. Unless the unthinkable occurs and utilities start going bankrupt, structural changes in the industry are more likely to be incremental than radical—but while helpful, small changes may not be enough to save the nuclear option.

Toward New Technology

A different strategy may be more effective in the long run: developing reactor systems that are more compatible with the electric-power industry's present structure. It is commonly argued that technological "fixes" have only a marginal role to play in achieving nuclear recovery. Indeed, the industry itself has become one of the strongest adherents of this view. Its agenda for survival during the 1980s and 1990s emphasizes reform of plant siting and licensing, small modifications of current light-water reactors, greater standardization of reactor design, and the hope that the nation's economy will improve. With only one exception, major technological innovation does not figure in the plans of the industry or, for that matter, in the recommendations of its critics.

The exception is the breeder reactor, the largest item in the federal nuclear-energy research budget. The breeder produces more fuel (in the form of plutonium) than it consumes, and in principle offers up to a 100-fold increase in the utilization efficiency of uranium. It is thus seen as the logical replacement for light-water reactors once low-cost uranium resources have been depleted. But even the strongest proponents of the breeder do not claim that it can solve the industry's current problems. Indeed, unless those problems are solved, the case for the breeder breaks down.

While skepticism regarding technical fixes is often well deserved, perhaps the pendulum has swung too far in the case of nuclear power. I believe that reactor designers, armed with today's knowledge of the strengths and limitations of utilities in financing, constructing, and operating nuclear plants, could develop systems that are more attractive to prospective buyers. For example, the optimal reactor size for future plants may be smaller than the 1,000- to 1,300-megawatt range now favored. For utilities with modest and slowly growing demand—that is, most of them—smaller units would be easier both to finance and to integrate into their systems.

Manufacturers argue that economies of scale jus-

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September, 1982

To M.I.T. Students:

Now that you are entering the final stages of your educational programs at M.I.T., I want you to begin an acquaintance with the Alumni Association as prospective members. It is with real pleasure, therefore, that I welcome you as complimentary subscribers to the student edition of the Association's magazine, TECHNOLOGY REVIEW.

TECHNOLOGY REVIEW has a two-fold assignment: to provide for all its subscribers a sense of current issues and developments in technology and related fields, and to provide for all alumni continuing contact with the Institute and among themselves. TECHNOLOGY REVIEW is published eight times a year for some 35,000 alumni and over 40,000 "paid" subscribers who receive it as a professional publication. The student edition will be sent to you without charge five times during the current academic year.

Nearly 70,000 former students of M.I.T. are carried on the rolls of the Alumni Association. When you graduate from the Institute, the Association will be the means for your continuing involvement with M.I.T. and contact with your classmates -- as it has been for me, despite the distance between Cambridge and West Coast, where I have lived ever since graduating. Through the Association, M.I.T. alumni are active in over 100 M.I.T. clubs throughout the world, as workers for the annual Alumni Fund, and as Educational Counselors interviewing prospective M.I.T. students. We also serve on numerous committees, trusts, and boards in support of the Institute and of our fellow alumni. We sponsor and participate in a number of conferences and special events both on and off the campus.

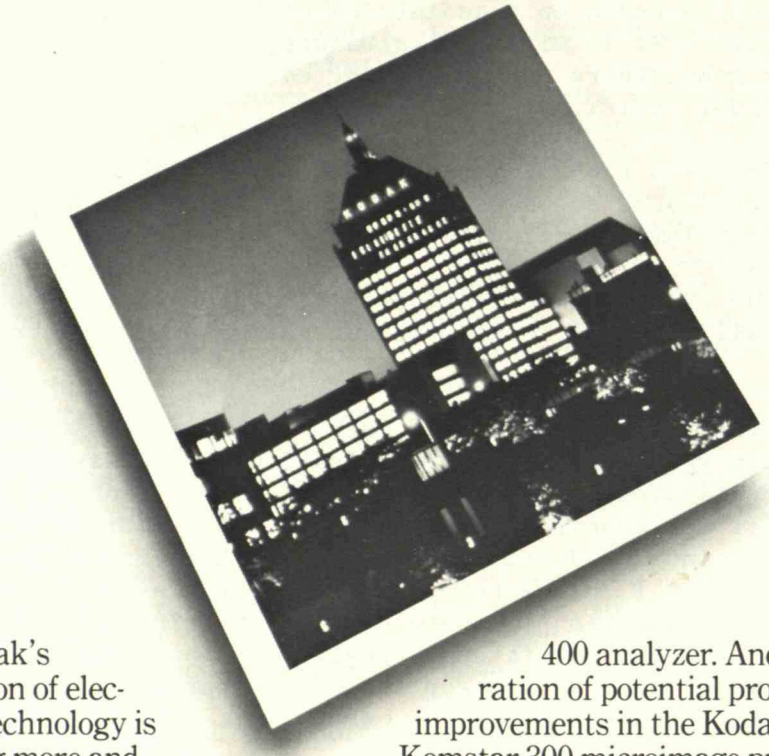
We hope that as a student you will join us in some of these activities, many of which are announced in the pages of TECHNOLOGY REVIEW and TECH TALK. Alumni enjoy meeting students--not only because we are anxious to keep in touch with M.I.T. but because we are sincerely interested in your well-being and your understanding of the professions which you are likely to serve after graduation. During the year you may have opportunities to visit with alumni to share your experiences at the Institute and discuss your future plans and interests; we hope you'll find these occasions interesting and even helpful. Please come into the Alumni Center (Room 10-110) to learn more about the Association and to arrange to join in alumni activities.

I trust that TECHNOLOGY REVIEW will serve you well, and that the habit of reading it will lead to a sustained relationship with M.I.T. after graduation. I also hope to greet each of you personally at one of the many occasions when alumni and students will come together during this academic year.

Denman K. McNear

Denman K. McNear '48
President

One of the nation's top companies in sales of electronics-related equipment is Kodak.



Kodak's application of electronics technology is becoming more and more extensive every day. That means we have growing career opportunities for electrical/electronics engineers.

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If you want to expand your horizons to meet the Kodak challenge, see a Kodak recruiter on your campus. Or send your resume to:
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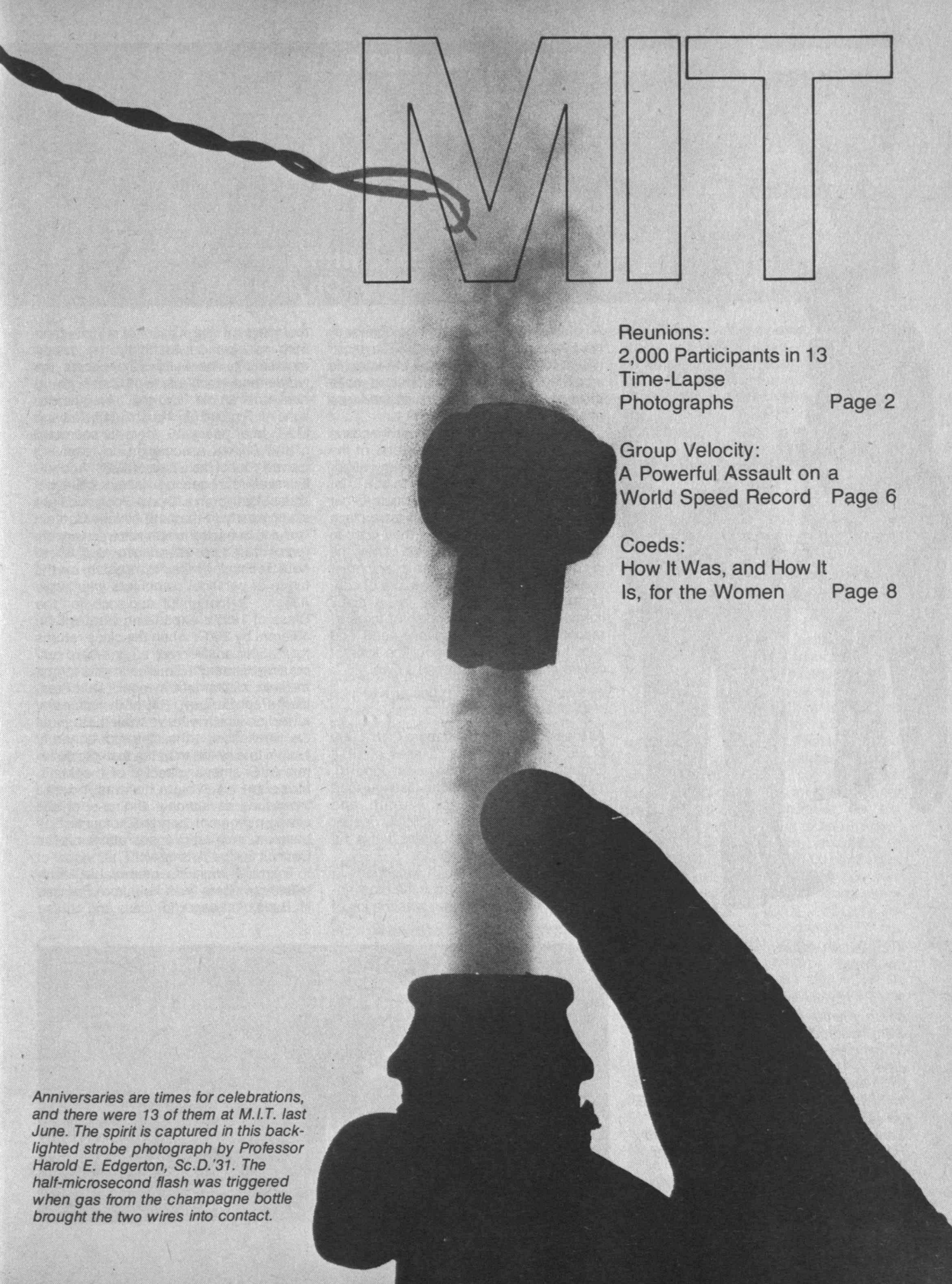
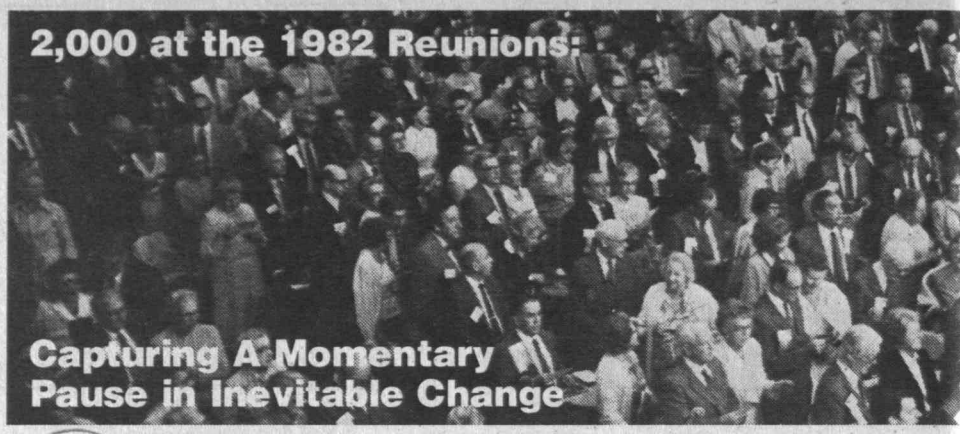


Anniversaries are times for celebrations, and there were 13 of them at M.I.T. last June. The spirit is captured in this back-lighted strobe photograph by Professor Harold E. Edgerton, Sc.D.'31. The half-microsecond flash was triggered when gas from the champagne bottle brought the two wires into contact.

2,000 at the 1982 Reunions:



Capturing A Momentary Pause in Inevitable Change

All of us know how time brings change in tiny, subtle daily increments. The fascination comes when these all-but-invisible increments are suddenly added to make a five-year assessment, like a time-lapse photograph.

To see themselves and their friends in such a photograph is surely one of the incentives that motivates so many of her sons and daughters to return to M.I.T. for the quinquennial reunion tradition. Other incentives, too: the nostalgia for a place whose residents never lose their pride in association with a special kind of hell, the joy of seeing friends unseen in any other context, the unabashed pleasure of conversation, food, and drink in so many memorable places, the relish of three irresponsible days with every need and care fulfilled, curiosity about the lives of others in the context of one's own.

"You Can't Go to Heaven . . ."

All these and more lured more than 2,000 of the faithful from the Classes of 1913 through 1982 to Cambridge last June 10, 11, and 12 for celebrations distinguished by an atmosphere of warmth and quiet—substituting a thoughtful, deeper serenity for the boisterousness that is the Ivy League reunion tradition.

There were just enough exceptions to this pensive mood. Perhaps the most notable seen by this reporter was the joy of members of the Class of 1917—their 65th reunion—in teaching the young members of the M.I.T. Chorallaries the words and spirit of "You can't go to heaven in an old Ford car." And the delight of Richard A. Knight, '47, leaving M.I.T. after nearly 10 years as secretary of the Alumni Association, in receiving the red coat of the Class of 1928. And roller skaters regaining (some of) their almost-lost youth at a post-Pops midnight skating party in the new Athletic Center.

But for most the emphasis was very different: a record attendance at a three-hour Technology Day symposium on the future of personal computers (*see page A3*) . . . a thoughtful audience for the Class of 1957's experts on what will be different by 2007, when the class returns for its 50th anniversary . . . a record outpouring of nearly $5 million in gifts for the Institute, a "dramatic symbol," said President Paul E. Gray, '54, of the forces of attraction which were at work throughout the weekend . . . the status of honorary alumni to a historian of the Institute (Warren A. Seamans, director of the M.I.T. Museum, at which he has hosted thousands of alumni) and one of the strong patrons of its arts (Professor Roy Lamson, retiring as secretary of the Council for the Arts at M.I.T.).

To make reunions memorable, committee members (with help from Frances H. Bangs, manager for class and course

Top: *"Arise ye Sons . . ." at Tech Night at the Pops.*

Right: *Celebrating life, not mourning death. Alumni deceased in 1981-82 were honored on Technology Day with 30 minutes of unconventional praise, including "Glory Glory Hallelujah" and "You Are My Sunshine" lead by a quartet including (left to right) John E. Ward, '43, banjo; Truman S. Gray, '29, clarinet; Samuel J. Keyser, '77, trombone; and Harold E. Edgerton, Sc.D. '31, guitar.*

Far right: *the computer show in Kresge.*

programs) scheduled events throughout eastern Massachusetts. There were parties at the President's House, the Pierce Boathouse, all the residences, the Student Center, and the M.I.T. Museum. Buses carried reunioners to such landmarks as the John Hancock Tower, the Quincy Market, the *Constitution*, the Gardner Museum, Salem's Peabody Museum, the Museum of Fine Arts, and the Eastern Yacht Club in Marblehead. Most found the Boston Pops with guest conductor John Lanchbery lacking the fire and verve of Fiedler and Williams, but it was still unmistakably the Pops in Symphony Hall.

"Still Noodling on the Clarinet"

The participants in these quiet, caring good times were 2,000 extraordinary people. Consider, for example, the 50-year Class of 1932, now mostly retired. More than half have been company presidents. Among their achievements, as recorded in their 50-year book: project manager for the design and construction of the Tidewater Grass Roots Petroleum Refinery, built in record time and under budget . . . in charge of the process development for the gaseous diffusion plant to separate uranium-235 during World War II . . . inventor and manufacturer of the world's most widely used viscometer

continued on page A4

Four prophets of personal computers at Technology Day. Left to right: Professor Nicholas Negroponte, '66, of M.I.T., Koji Kobayashi of Nippon Electric Co., Professor Michael Dertouzos, Ph.D. '64, of M.I.T., and Philip D. Estridge of IBM. It was a symposium about a nonsubject, said Professor Negroponte: "Computers are not yet personalized. . . . They are dreadfully hard to use and talk to." But Dr. Kobayashi pressed his dream: "People talking to each other at any time and in any place . . ." (Photo: Calvin Campbell)

Personal Computers: Dreaming and Building

Koji Kobayashi is a practical man. As chairman of the board and chief executive officer of Nippon Electric Company, Ltd., he could not be otherwise. But he is also a humanist and a dreamer. "The dream of my youth," he said in a symposium on personal computers on Technology Day (June 11), was to have "people talking to each other at any time and in any place on Earth." With the wisdom of age and the benefit of advances in computers, communications, and their integration—or "C&C," as he calls the trend—his dream has expanded considerably to "all mankind exchanging and utilizing information together at any time and in any place."

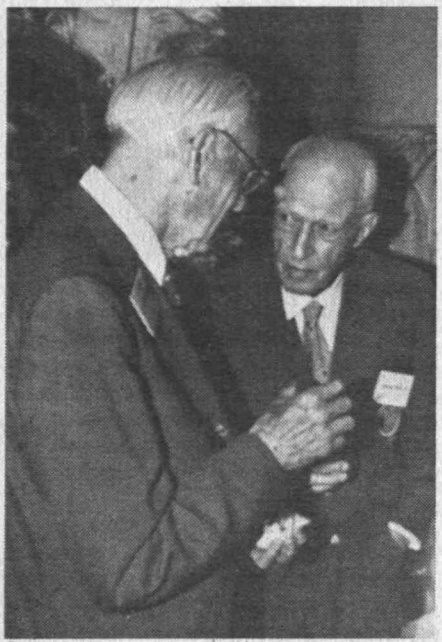
But although the shift to popularization has been significant, he observed, there is still a long way to go in more closely meeting human needs. And "one of the ultimate goals of C&C technology, according to Dr. Kobayashi, "is to enable people of different countries to talk to each other freely in their own languages" through the intermediary technological step of automatic translation. This dream will require advances in speech recognition and synthesis (which Nippon Electric is pursuing and which Dr. Kobayashi predicts will be commercial in another decade) and in machine translation, where he concedes that enough work still needs to be done—mostly in linguistics—that a timetable is hard to provide.

Philip D. Estridge, vice president of IBM and general manager of its Personal Computer Division, brought to the Technology Day Symposium a more pragmatic view of the future. It's true, he admitted, that "lots and lots of personal computers are being sold. But what's not so clear," he said, "is what people are doing with them." They're playing, he thinks—a computer's "almost-instantaneous response makes you feel good." But as for being really important in displacing people and their work, personal computers need to be more friendly, to look more like furniture than technology.

The star of the show was Professor Nicholas Negroponte, '66, on leave from his chair in the Department of Architecture at M.I.T. to direct France's World Center—its hoped-for "Bauhaus of personal computers," as one symposium member put it. Professor Negroponte was colorful and informative, as expected, but he turned out to be no knee-jerk defender of personal computers. In fact, he maintained, "personal computers do not exist: computers are not personalized; they have not yet been integrated into larger systems, and they are dreadfully hard to use and talk to." At the moment, he regards "personal" as simply a synonym for "cheap."

Professor Negroponte's idea is that, to be successful, personal computers must really be *personal*, fitted to the habits and needs of each of us individually. When this happens personal computers "*will* cause profound changes," Professor Negroponte said, "but for each person the changes will be different." Mass-marketing approaches as currently pursued are not the answer at all. "If we look for one kind of home information system to sell on a large scale," he said, "we are looking in the wrong direction."—*S.J.M.*

A



C

continued from page A3

. . . chairman of the Board of King Monskut's Institute of Technology, Bankok, Thailand . . . syndicated columnist on wine appreciation . . . supervisor of design and construction of the Portland-(Maine)-to-Montreal crude oil pipeline . . . president of the San Francisco Art Directors Club . . . president of the American Patent Law Association . . . director of environmental health for the Hawaii Department of Health for 25 years . . . author of eight texts on analog and digital electronics . . . 21 years as superintendent of the Minnesota School for the Deaf . . . professor of pediatrics at Harvard Medical School.

They do well in retirement, too. Edward R. Levine, '32, who guesses he's rowed "considerably more than 50,000 miles since 1924," now does 600 miles a year on the Charles River. Edmund F. McLaughlin, '32, has travelled to Sikkim by Land Rover, on the Nile by boat, over Mt. Everest by air, and "through Bali by enchantment." After serving in Asia with the Air Force, George W. Muller, Jr., '32, returned to the Himalayas to collect rhododendrons as a hobby . . . And then there's Robert B. Semple, '32, formerly president of Wyandotte, who admits to "still noodling on the clarinet."

And the best part of it is that most of them will be back in another five years, to see each other and their M.I.T. again—and give those of us who have waited them out in Cambridge a mirror in which to see those inevitable but otherwise invisible increments.—*J.M.*

Records Fall in $4.9 Million Reunion Giving

Total giving of $4.9 million during the five years culminating in their reunions was reported by the three principal reunion classes—1932, 1942, and 1957—at the Technology Day luncheon on June 11. And tradition was broken by the Classes of 1977 and 1982 announcing their own totals of gifts and pledges of over $32,000.

Responding, President Paul E. Gray, '54, called M.I.T.'s "long tradition of alumni support . . . a crucially important resource for the future if quality is to be maintained."

The gifts:

☐ A total of $1.375 million from the Class of 1932, including contributions by 64 percent of the class, reported by Robert B. Semple, reunion gift chairman. He said it was the second largest 50-year gift in M.I.T.'s history. In addition, said Mr. Semple, 22 members of the class had committed themselves to future gifts of at least $800,000.

☐ A "trend-setting" $1,876,462 from the Class of 1942, reported by its president George J. Schwartz for Floyd A. Lyon,

D

B

reunion gift chairman, who was unable to be present. Five years ago, explained Mr. Schwartz, the class determined to mark its 40th anniversary by doing "something very special." And they did, reaching $1 million for a Class of 1942 Professorship two years ago and then continuing to fund as well a career development professorship. The final total, said Mr. Schwartz, represents the largest single five-year gift from living alumni in M.I.T. history.

☐ Not to be outdone, Jordan L. Gruzen, reunion gift chairman for the Class of 1957, had another record to put on the books: $1,664,739, the largest 25-year gift in history. In all 65 percent of the class participated, many of them making gifts and pledges to establish the Class of 1957 Career Development Professorship.

☐ An unprecedented fifth reunion gift: $15,000 from over 415 members of the Class of 1977—over 70 percent participation.

☐ A total of $4,100 and pledges of over $17,000 in the next four years from members of the Class of 1982. Matched by members of the Class of 1928, the seniors' funds have been used to complete memorials to alumni lost in Korea and Viet Nam in the lobby of Building 10, and to provide new furnishings which make that lobby a more informal social center in the academic buildings.

Their Crystal Ball Sees Automation and Vaccines

"He who lives by the crystal ball gets to eat lots of broken glass," warned Professor Edward B. Roberts, '57, of the Sloan School of Management, in introducing classmates assigned to tell a reunion audience what the world would be like 25 years hence, when (in 2007) the Class of 1957 returns to M.I.T. for its 50th anniversary.

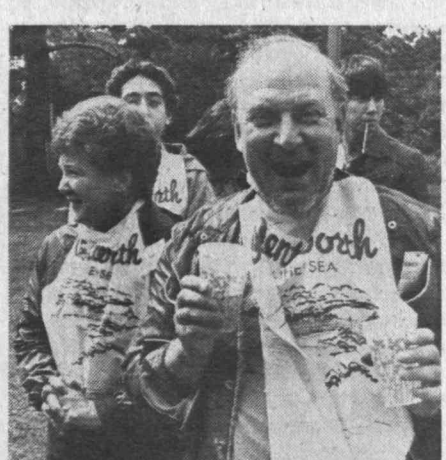
Throwing caution to the winds, Raymond S. Stata, '57, president of Analog Devices, Inc., told his classmates that current and future progress in electronics and communications will have the "most profound impact on professional and social lifestyles." Electronics will replace books and paper, he said—changes as large in their way as the transition from the horse-and-buggy to jet aircraft. There will be "orders of magnitude increases in the speed and complexity of circuits" and in what they can do for us. Automation will be "everywhere," and it will virtually "wipe out unskilled labor in the U.S."

What will happen to all those people? Mr. Stata was asked. "Updating human assets will be one of the most important managerial problems" of the next quarter-century, he replied.

Changes in medicine, too, said Renata Cathou, '57, of the Tufts Medical School Department of Biochemistry. Most important may well be those in our understanding of the immune system, Dr. Cathou said—"a vast network of cells, messengers, and receptors existing in a very delicate equilibrium." Multiple sclerosis and juvenile rheumatoid arthritis are linked to the immune system, and in 25 years, Dr. Cathou predicted, both diseases will be "understood and probably controlled." The immune system also figures in viral diseases and cancer, and Dr. Cathou spoke of "a successful attack on cancer" through this system—and perhaps successful vaccines for the common cold and herpes-caused venereal disease.

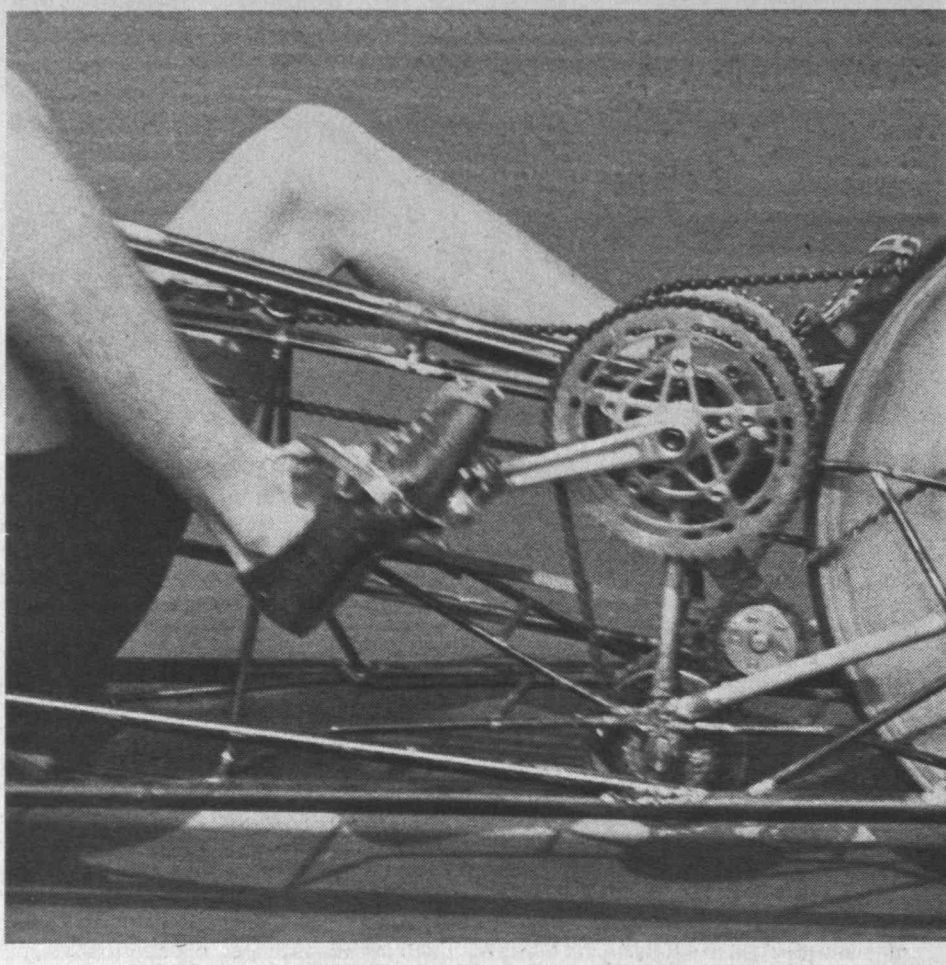
Among those present:
***A**—Professor Irwin W. Sizer (left) with Elmer Stotz, '32, and G. Edward Nealand, '32.*
***B**—Parke D. Appel, '22, Donald F. Carpenter, '22, and Carole A. Clarke, '21.*
***C**—Winthrop Potter, '22, and Fearing Pratt, '22.*
***D**—Geraldine and Edward Keane, '22, at the Gardner Museum.*
***E**—President Paul E. Gray, '54 (left) with Alexander W. Dreyfoos, Jr. '54, and Mrs. Dreyfoos.*
***F**—James R. Killian, Jr. '26 (center) with A. Carleton Jealous, '42, and Mrs. Jealous.*
(Photos: Scott Globus, '82)

E



F

The first rider in this extraordinary vehicle steers with controls mounted under his legs and pedals the twin wheels at the front. The two riders directly behind him power the single wheel between them with hand cranks as well as pedals. Two additional riders power the other single wheel toward the rear. The riders in the picture opposite are John Hsu, '84, Ronald Reade, '84, Vijay Jayaraman, '84, Mark Childs, '83, and Steve Altes, '84. (Photos: Calvin Campbell, James J. Snyder, '80)



Group Velocity: Aiming for the Human-Powered Speed Record

The yawning opening in a huge old warehouse set back from the street in an overgrown lot of Cambridgeport beckons the curious into its cavernous interior. In the dim recesses of its cluttered space is a strange, long, thin object—a veritable revolution in human-powered vehicles—made of tubes and what look like bicycle parts and custom-made variations on that theme.

This extraordinary piece of technology was designed and built by M.I.T. students who call themselves Group Velocity. Their purpose: to win the world speed record for human-powered vehicles, and to participate in the International Championships in California in October. The record speed now is 62.93 miles an hour (on a flat surface without being drafted by a truck), held by a two-person vehicle. Group Velocity will challenge that record with a 40-foot long vehicle powered by five riders.

"We have 7,000 feet of runway and we expect to get it up to 70 miles an hour," says Bruno Mombrinie, '82, founder and project coordinator. He and a core of students in mechanical engineering and aeronautics and astronautics have been working on the project for about a year—5,000 hours of time mostly by three to five people, he estimates, but including additional contributions from perhaps 60 different people who come and go according to their time and enthusiasm.

Upon closer inspection, their creation is full of surprises: four wheels are distributed along the 40-foot frame. The front two are singles spaced 10 inches apart, while the middle and rear wheels consist of two bicycle rims welded together. The front wheels are unique: a complex mechanism allows them to steer and drive the vehicle at the same time.

The name of the game is aerodynamics; you want to minimize the force required to move this long cigar-shaped form through the air. To reduce wind resistance riders will be encased in a fairing made of an opaque flexible plastic material from General Electric called Lexan. It is 20 thousandths of an inch thick—approximately the thickness of six pages of this magazine—of an off-white color. Oval wood bulkheads every six feet will hold the fairing, which will zip up.

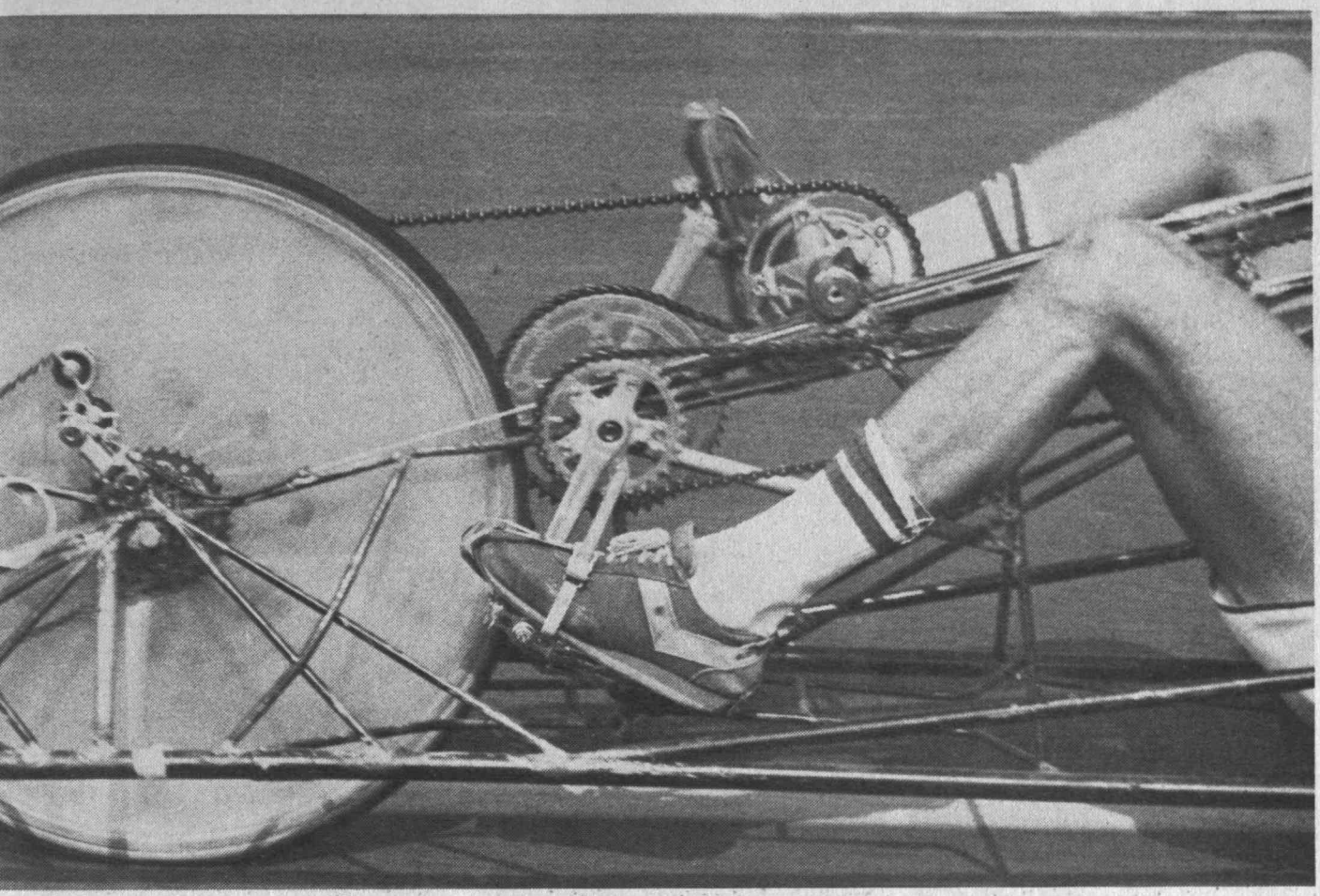
The principal problem is air displacement. You want to put as much people-power as you can behind the necessary displacement, explains Mombrinie. No one has attempted the speed record with more than two riders, and there is a limit to how many can be effectively added. William Chesterson, '82, came to the conclusion in his thesis that five is optimum; we had estimated four to seven, says Mombrinie. There is no problem of keeping peddlers in sync; all the wheels go the same speed. (One rider can't affect the rest, all any can do is keep up.) If you keep pressure on your pedals, you're doing O.K.

Not Easy to Depart from the Conventional

Tests of stability proved successful: we feared that loaded with 1,000 pounds of riders we'd have to concentrate too much on steering to keep the machine on course. But we were wrong: it will go straight by itself, says Mombrinie. And the first time out it reached a speed of 25 miles an hour with only one pedaler.

Two sets of riders sit facing each other in pairs, ensconced in semi-recumbent seats and pedaling with both hands and feet. The fifth faces forward to steer with his or her hands, while pedaling. The red seats with black zig zag stripes are surprisingly comfortable, once the rider maneuvers around the frame to get in.

Braking power comes from a parachute attached to the back and primarily from ground brakes, which are mounted away from the wheels. "Any brake on the wheel runs a risk of locking up the wheel," explains Mombrinie. It



was not easy to depart from the conventional mechanism—the brakes took a day to make, but it took a month to figure out the way to release them properly.

Every time the concept suggests a bicycle, the special stresses dictate a different approach; so the design time always stretches. "The wheels took a week to figure out the spokes," says Mombrinie. "I've never spoked a wheel, but I learned. There are two ways to spoke a regular wheel, and only one is right. On *this* wheel, there are eight ways, and only one is right. It's hard to figure out which. I took a totally different approach. I usually rely on experts but in this case it stumped a lot of people; it doesn't look like a regular bike."

The frame evolved from a quarter-scale model built of material usually used in chemistry. When the geometry was right, the rubber joints held together, says Mombrinie. The students concentrated on designing one whole section. After lots of modificatons, they finally replicated that design for the rest of the vehicle. The design includes an airy frame that holds the weight of the riders, and a more complex shorter design between riders. The tubular steel material is flexible; weight is thus distributed evenly when the bike goes over bumps.

It was important to fortify the strength of the tubes where the riders strained. Pushing the wheels may put the power of a 500-pound leg press on the structure. Custom-made hubs are designed to take that load without breaking. (Bicycle components were too light—they bent out of shape). The front end drive is also custom made. The wheel axle is one-half inch, comparable to a motorcycle axle, rather than that on a bicycle.

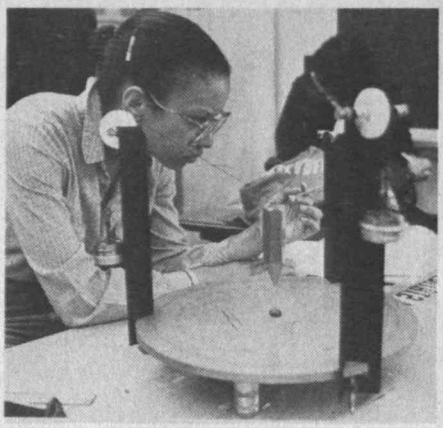
The length of the vehicle (40 feet) was influenced by the fact, essential for transportation, that tractor trailers have 40-foot long flatbeds. The bike structure without the nose cone is 32 feet; built in the materials science machine shop (which was about 32 feet and 6 inches long, explains Mombrinie). It had to be taken out through the window and moved to its current warehouse. Its height is 32 inches.

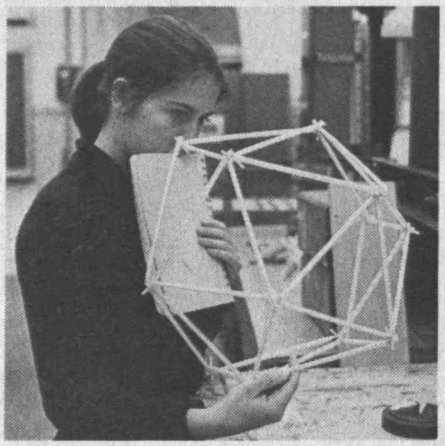
Athletes are Plentiful; Money Scarce

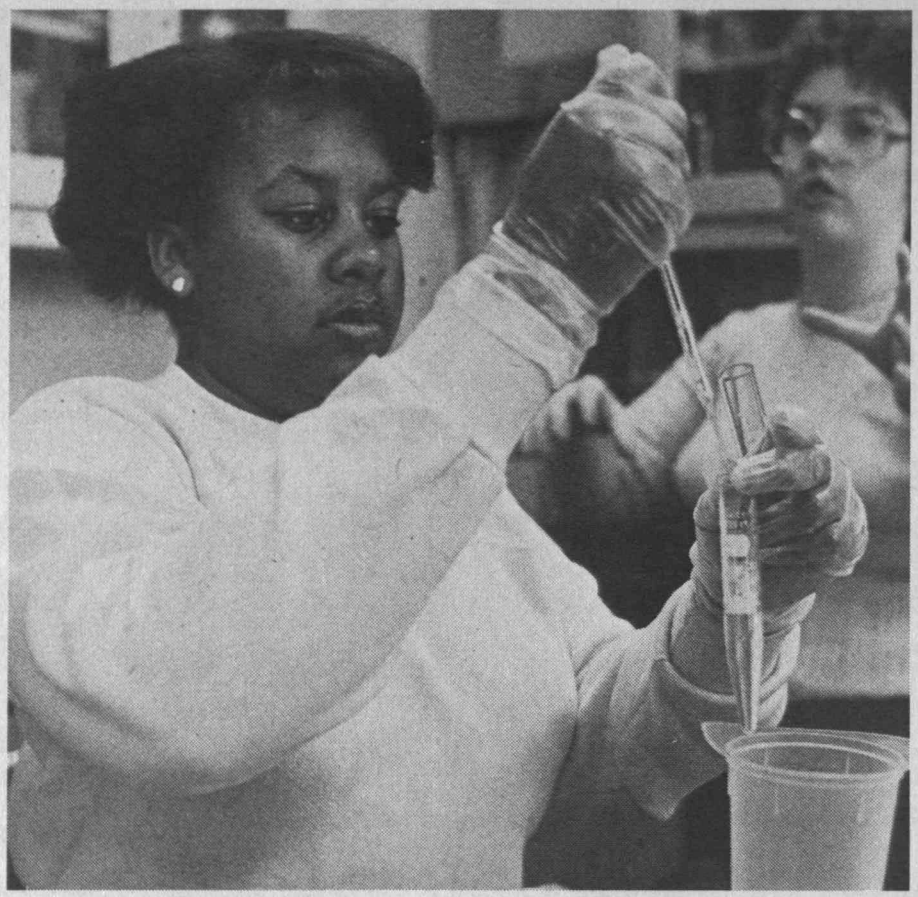
Who will ride it? There will hopefully be a women's and men's team. "We haven't had any problem with the best athletes in New England asking to participate," says Mombrinie. "That is the least of our problems. We won't be the ones riding it," he adds—a bit wistfully, I think. "We're out of shape—we stay up all night working on it."

Money is a larger problem: there have been contributions from M.I.T., Grumman Aircraft Corp., Dana Corp., Shimano, Inc. (a Japanese bicycle firm), Albany International, (the Kevlar for the spool transmission). But the group has already spent $12,000 (Mombrinie has invested about $4,000 of his own money in the project), and another $22,000 will probably be needed to finish the vehicle and race it in California.

The eight-year-old competition draws vehicles from all over the country and lasts throughout one weekend.—*M.L.*







"What a Difference the Women Make!" And How We Court Them

Some women study at M.I.T. because "someone bet me I couldn't get in," others for very pragmatic reasons: they want the best in science or engineering. Without exception those who come are "extremely capable people," says Marilee Jones of the Admissions Office. And "what a difference the women make!" she says. (All photos: Margo Woodruff)

"There is an organized plan to recruit more women for M.I.T., and it's working. In 1981-82 over 1,750 women were enrolled, up from less than 800 a decade earlier, and women are typically now nearly 25 percent of the entering freshman classes.

But that's still not as good a showing as it should be for an institution that is committed to equality of opportunity in the professions, says Peter H. Richardson, '48, director of admissions.

The primary route to improving the balance is through increasing the number of qualified women who apply. But there are two secondary issues, too: to increase the number of women with high school studies in mathematics and science who might thus qualify for M.I.T., and to discover why high school seniors who might come to M.I.T. decide not to do so.

Here is how Marilee Jones, assistant director of admissions, describes all these questions and what M.I.T. is doing about them.

Recruitment begins, says Ms. Jones, with the list of the top 10,000 high school juniors with scores of 650 or more in the Scholastic Aptitude Tests. We send these women a booklet of information with a card on which to ask for application forms.

But we have a lot of competition—these students get besieged with four-color glossy recruitment brochures from many schools. Of the 10,000 booklets we send, about 3,000 cards get returned to us. We send them final applications, and receive about 1,000 back. So 7,000 of the original group rule us out almost at once, and only one-third of those who receive final applications actually apply. We want to increase the number of women in this group who apply.

Campus visits and personal contact are especially important to women, we find. Hundreds of our men applicants are described as "loners" by themselves, by teachers, by guidance counselors. But the women are much more connected to other people. They write in their applications about their friends, family, teachers.

So we communicate with them through letters, we plan to send them *The Tech* and *Tech Talk* and to invite them to come to the campus and stay overnight.

Another tactic: after they've been admitted, we send them all tee-shirts. We say "here's a token of our esteem." When they wear the tee-shirts to school, they advertise M.I.T. and they also identify themselves with the Institute. What better way to be personal and warm?

Still another way to affect their choice is to mail our acceptance letters earlier than the Ivy League; we send out an admissions letter at the end of March, when applicants are expecting it in April. Then early in April we have a telethon,

when women (faculty and staff also participate—and a few male students who want to be connected and involved) on campus call all the women who have been accepted to answer questions and share their enthusiasm about M.I.T.

Prospective students have been notified when they will be called, and we ask them to please be home at that time. Last year we called *all* the women who had been accepted. They had lots of questions, often about social life—just the things the M.I.T. myth is all about. It worked—the yield was up.

Why They Come—And Why They Don't

Applicants for M.I.T. must complete math through trigonometry, physics, and chemistry in high school. But women often don't take physics in high school. In that case, they can be admitted only if they make it up in the summer before entering.

The women who apply and who come here are bright, with many talents. I'm struck by their diversity: they are extremely capable people who often don't realize it. Reasons for choosing M.I.T. vary from the practical to the ridiculous. "Someone bet me I couldn't get in," might be a reason to apply. And a big decision may be made out of, for example, an impromptu conversation held on a plane. One such conversation led to a suggestion to visit M.I.T. The student spontaneously acted on that suggestion, M.I.T. became her first choice, and she came. It was the right conversation at the right time.

Many have managed to overcome peer pressure to *not* go to M.I.T. And they must override that opinion from parents and guidance counselors as well. Nevertheless, I'm struck with how few of the freshwomen think there are obstacles set before them because they are female. Their paths have been less cluttered: equal athletic facilities have been available to them in high school, for example.

Perhaps more important than the question of why women come here is why they don't. We send those that reject our invitation a form that asks their choice of college and what impacted on their decision, and we analyze this information.

From year to year we lose a sizeable number of students to one place. Cornell was last year's major competitor; this year Princeton seems to be. We always lose to Harvard, but not in the numbers one expects. The decision to enroll often comes down to money: whichever aid package is the best.

Keep Your Options Open

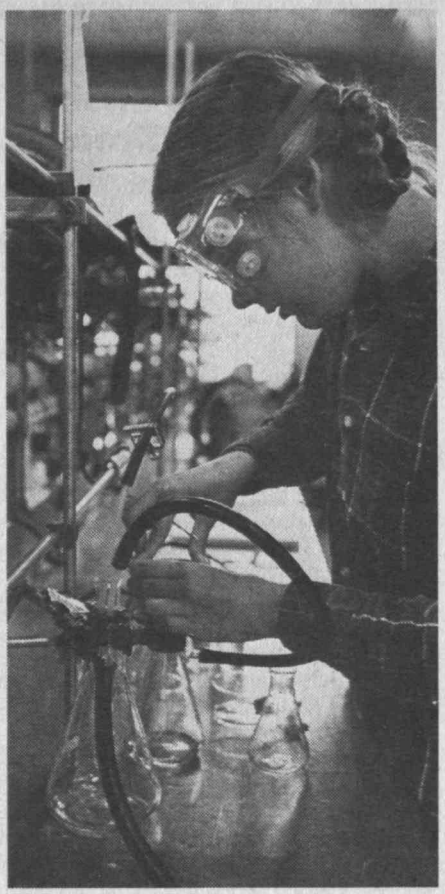
We're trying to get women to increase their options. Teams of M.I.T. alumnae are now arranging to talk to women in high schools. Their message: take as much physics and math as you can; then you are able to apply anywhere, and you still have the option to change the path of your life. Avoid boxing yourselves in by the choices of subjects you study in high school.

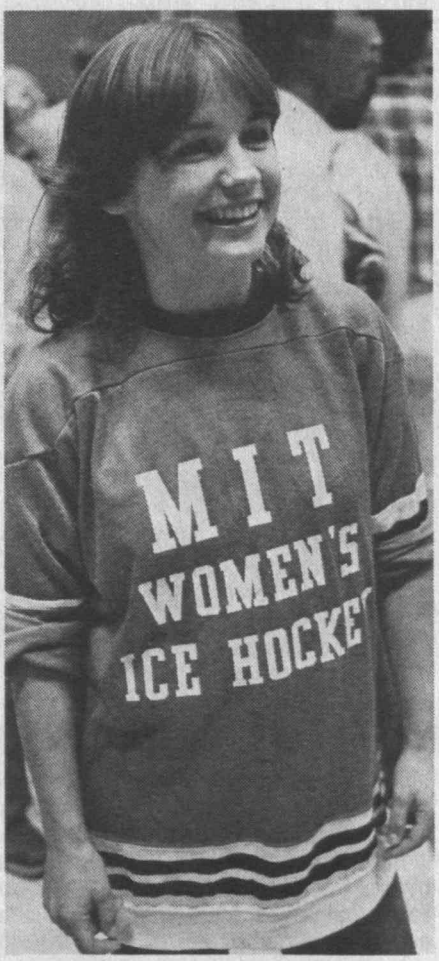
These alumnae are not selling M.I.T.; they don't answer admissions questions. The purpose is to demonstrate M.I.T.'s concern for high school students. We want women to apply here, but we really want them to have solid preparation, to be able to be admitted to many different schools; we want them to see what is right for them. Princeton may be better for some, or Carnegie Mellon, for instance. We don't have to meet the needs of all women.

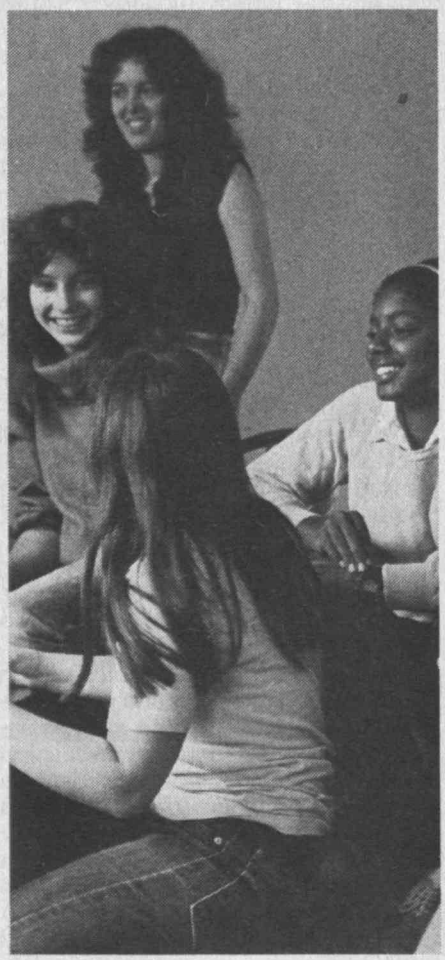
Women Bring Special Talents

Once freshwomen arrive, they are offered special treatment—they are, after all, a minority here.

This place is better for having women here. What a difference! As a tutor, I've seen my floor in the dorm change from 10 percent to 50 percent women—and I've watched the whole tempo and atmosphere change. It is a more civilized and caring place.—*M.L.*







After 60 Years, the Coeds Are Still Dreaming Their "Impossible" Dreams

by Martha Munzer, '22

Before she returned to M.I.T. for her 60th reunion last June, Martha Munzer, '22, asked Technology Review*: Would we like to have her talk with some of today's coeds and then tell us how her recollections of M.I.T. compare with today's reality? We would indeed, and on these pages she reports her visit with a circle of today's coeds. Later (above) she shared a moment with President Paul E. Gray, '54.*

Last spring's 60th reunion of the class of '22—my class—at the Massachusetts Institute of Technology brought with it the rare opportunity to learn at first hand what it is like to be a girl at this famed scientific institution in 1982.

We sat down together, a few of the undergraduates and I, in an attractive lounge at McCormick Hall, the first dormitory ever built (1963) for M.I.T.'s female students.

To create a feeling of relatedness, I told the girls briefly of my own experience in choosing and entering Tech some 64 years ago. In 1919, fresh from high school, flushed with encouragement from a well-loved science teacher, I impulsively decided to become an engineer. There was only one hitch—I was a girl, and technical schools were, I believed, solely for men.

A study of the M.I.T. catalogue with the magic words "female students" tucked into a back page led eventually to my admission as a freshman, despite the dean's advice to the contrary.

No welcome awaited me; no period of orientation; no quarters provided for an out-of-town girl; not anything but the quizzical stares of a host of young men whose eyes seemed to be asking, "What the dickens are *you* doing here?"

Now turning to the girls in the small circle surrounding me in McCormick Hall, I asked each of them to tell me: "Why are *you* at M.I.T.? And now that you're here, what is it that you are doing?"

Ellen, from Illinois, was the first to reply: "I'm here because I love learning. Physics is my major because there are not many women in the field." I was interested to discover that Ellen's reason for choice of profession and mine were identical. I had proudly and perhaps unreasonably selected electromechanical engineering more than six decades ago because there was only one woman ahead of me.

Debbie, from New York State, was a student of architecture and urban planning. "I left M.I.T. for one year, but discovered I missed it so much that here I am, back again. Everyone asks once 'Am I in the right place?' Now I *know* I am!"

Canadian Brenda felt that M.I.T. was on the frontier of science and would offer her the best possible training for electrical engineering coupled with computer science.

Jean from Maryland had chosen the path of human systems and the life sciences.

"I'm beginning to think about medical school now that I'm a junior."

Betsy from Virginia smiled broadly, "My being here is a joke."

"A joke?" I queried in surprise.

"Yes, you see I didn't get into the college of my first choice."

Betsy is interested in business, economics, and management. I gathered that in this, her Freshman year, she had made the best of the jest.

Still Fighting the Image

My next question was about the living quarters for girls. Did they all live in dorms for women?

"No indeed," I was informed. "During Orientation Week we learn of our options: There are McCormick Hall and McCormick East, each with a somewhat different flavor, for girls only; most of the other dorms are becoming co-ed and even some of the fraternity houses. As a matter of fact, there is only one all-male dorm left on the campus."

Betsy had chosen a frat house; the others, I believe, had selected a McCormick mainly because they had made such fast friends at orientation time.

"How about your social life?" I asked. "Do the young men still prefer the more glamorous girls from near-by colleges?" They grinned and nodded.

"Just as in my day," I responded with a chuckle. And then I queried, "Do you consider that Tech is still a man's world?"

Four of the five felt that it was, and this despite the fact that about a quarter of M.I.T.'s students, both undergraduate and graduate, are female.

There was time for only one more personal question: "Are you interested in marriage and family life as well as in scientific careers?" Again, four out of five answered decisively and affirmatively.

Humanities: Obligation or Enrichment?

Leaving the strictly personal realm, I was curious to find out about present curricular requirements. A question concerning the role of the humanities at today's Tech (they were almost non-existent in my day) elicited the response that for those in science and engineering, one liberal arts course in each of eight semesters is now a requirement. But the faint snicker with which my query was answered made me feel that the humanities seem more like an obligation than an enrichment to these particular girls.

The answer to another question distressed me. It appears that engineering students—those who are to have the skill and power to change the face of the earth—may graduate quite as ignorant as I was in respect to the principles of ecology—the discipline relating to the delicate and extremely vulnerable bal-

ance of nature. Of all people, shouldn't engineers be required to become literate in this field? The girls, it appeared, had not pondered this question but seemed to want to think about it.

There was so much still to explore together but time had run out. After I had said a cordial goodbye to the group, a pamphlet entitled "Women at M.I.T." was useful in giving me several further insights.

For example, Tech now offers girls, in addition to professional training, the chance to perform in a symphony orchestra, to play rugby or softball, to act in plays, to scull on the Charles River, to plan parties.

Putting Down Foundations and "Being Ourselves"

All of these activities have been made possible because the administration's attitude toward women both as students and faculty members gradually changed with the years. The opening of McCormick Hall in 1963 helped the female population to grow. There was another spurt when, five years later, McCormick East was added. But the largest increase came in 1970 when Dean Emily Wick, Ph.D.'51, suggested the removal of quotas for women.

The new and present policy is spelled out unequivocally: "The Massachusetts Institute of Technology admits students of any race, color, sex, religion, or national or ethnic origin to all rights, privileges, programs, and activities generally accorded or made available to students at the Institute."

I suddenly remembered the comment of one of the girls I had interviewed: "Tech is a truly tolerant place—that's one of the things I most admire about it."

"Yes," a second girl had chimed in, "We are *all* made to feel welcome and wanted regardless of our origin or life styles or even our sexual orientation. We are free to be ourselves, here at Tech, and to do our work unhampered."

And I gather that M.I.T.'s liberated women are not only doing their work and holding their own academically but are playing an active role in campus activities and student government. In recent years, two of their number have been elected class presidents.

I could not help recalling Brenda's remark that she had left M.I.T. for a year only to return because she missed the place—missed the seriousness of purpose, the stimulating conversations with her classmates.

The girls at Tech realize that the work is gruelling—far harder than at a liberal arts college. But they are motivated; they know the direction they wish to give their lives. These sturdy and still pioneering young women have been busily dreaming their "impossible" dreams.

The famed New Englander, Henry David Thoreau, wrote a book more than a century ago in which he described his dreams and their fulfillment in his own unique design for living. In the last pages of *Walden* you will come upon these words: "If you have built castles in the air, that is where they should be. Now put the foundations under them."

From my brief contact with that delightful group of young women at M.I.T., this is exactly what they seem bent on doing.

She Was a Lone Eagle on the Fenway and It Hasn't Washed Off Yet

by Marjorie Lyon

While Martha Munzer, '22, talked with five M.I.T. coeds last June (see left) *about life at the Institute today, she "kept things going"—her bright blue eyes sparkling—with tales of her own student life 60 years before. Here's how Marjorie Lyon, senior editor of the* Review *who was sitting in the background, heard it all.*

It was 1919, during World War I. I took a course in science, and I thought I would save the world. In the evenings I would work with Morse code. Someone suggested I should go to M.I.T. I applied and was accepted.

My straight-laced Victorian parents were terribly good sports. They allowed their 18-year-old daughter to go to a man's school and live in a hotel.

I took electromechanical engineering. Why did I choose it? I had only two reasons: I would be the only girl in the class, and it was supposed to be the toughest course. I felt I had to uphold the honor of my sex.

The women found a haven between classes in a room at M.I.T. where we could cook on a two-burner stove. Other than their companionship, I was a lone eagle living in the Hemenway Hotel on the Fenway. We girls went to "smokers"—a social gathering in the evening, where the men sang songs about M.I.T. I remember the songs—and that was 60 years ago. It was all the social life we had. Yet I never regretted the lack of social life.

M.I.T. taught me the value of work; nothing ever seemed quite so hard. It taught me to be flexible. Eight years out of college, when I was married and the mother of twins and a son, engineers were a dime a dozen. (It was 1930.) I couldn't get a job, so I went back to the high school I had started at and was hired as a teacher of chemistry and general science. I knew less than nothing. I went home at night saying "I can't face those brats another day." But it was my experience at Tech that allowed me to jump the hurdle of doing something new. I taught chemistry for 25 years.

I also got extremely interested in the relationship of people to the community. When I taught about coal, I thought, "Wouldn't it be great to take them into real life—into a coal mine?" I wrote to the head of United Mine Workers, and said I had a bunch of kids who wanted to see the mines. They took us in—we went into the mine and talked to coal miners. We learned more on those trips than in the lab. We went year after year as part of the curriculum. Eventually, we were invited into the miners' homes; and we invited them.

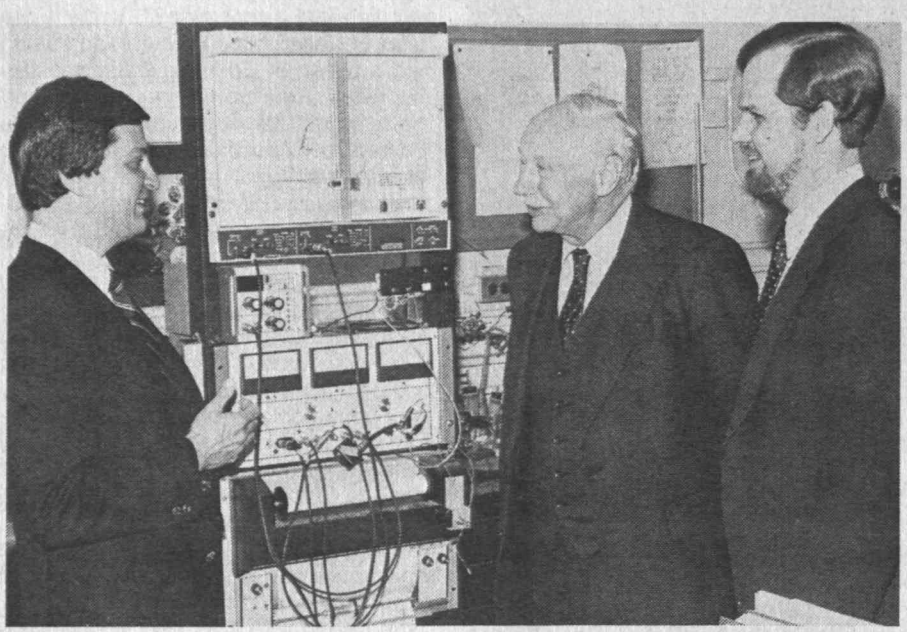
She pauses. Someday in the middle of your life, you might want to reach out to do something else. In 1954 I was running a science camp and we did a project in ecology. I looked up "ecology" in the telephone book, and it wasn't listed. No one was involved. And the only conservation education I could find (in 1954) was the last chapter of a biology book. There was almost nothing; I felt illiterate. I knew nothing of the laws of nature, yet I was supposed to be an engineer and *tamper* with them.

I got a job with a conservation foundation for 14 years. There I wrote books for young people about possible careers not often considered. I got help from experts.

In 1964, I had an idea to write a book on pockets of hope, in contrast to pockets of poverty. The foundation sent me wherever I wanted to go: to the panhandle of Alaska, to an Indian reservation, to a small watershed in the deep south where there was cooperation between the black and white people. It took me one year to find it, but I did. It was called Johnson Creek, where white farmers were flooded out and black farmers were starving. They realized they had to share one watershed or leave. I talked to one old couple who said, "We wanted to give our children something that wouldn't wash away." "What's that?" I asked. "An education," they said.

You're in a great place—you can do many different things with your education. I have—and all of it was one step after the other. The most important link was M.I.T. That magic word opens countless doors for you.

Courses



A new chapter in corrosion? ". . . the dubious objectives of continued waste and planned obsolescence" are now giving wax to "longer-range values more clearly identified with human survival," says Professor Herbert H. Uhlig, Ph.D.'32, professor of metallurgy emeritus. Professor Uhlig returned to M.I.T., late last spring, when the corrosion research laboratories of the Department of Materials Science and Engineering were named in his honor; he was M.I.T.'s principal scientist in the field for 40 years following his appointment in 1936. In the picture are Professor Ronald M. Latanision (left), director of today's corrosion laboratory; Professor Uhlig; and Associate Professor Gregory J. Yurek, associate laboratory director. (Photo: Calvin Campbell)

I

Civil Engineering

Professor **John M. Biggs,** '41, has retired from full-time faculty responsibilities after 35 years of teaching, research, and administrative work in the department at M.I.T. He is a specialist on structural dynamics—including the effects of earthquakes, winds, and traffic vibrations on structures—and on protective construction for nuclear weapons; and he has achieved recognition in the field of computer-aided structural design. Professor Biggs joined the faculty on completing his master's degree at M.I.T. in 1947; earlier he had taught civil engineering at Robert College, Istanbul, and practiced at Curtiss Wright Corp., and Fay, Spofford, and Thorndike. Among professional honors are the Moisseiff (1955) and Wellington (1960) Awards of the ASCE, the Fitzgerald Medal of the BSCE (1953), and the *Engineering News Record* "Construction Man of the Year" citation in 1965. He's a partner in the firm of Hansen, Holley, and Biggs, consulting engineers, of Cambridge, to which he is devoting increased time following retirement.

Muhamad K. Al-Momen, S.M.'80, reports, "I am presently a consultant at Arthur D. Little, Inc., working in the area of project program management for civil engineering and construction systems. My specific area of emphasis is related to organizational development and design for large projects. I am also active in the fields of project definition, planning, and control systems. My clientele so far has included the U.S. government and international commercial entities." . . . **Edward R. Bedrosian,** S.M.'55, treasurer of Polaroid Corp., has been elected one of five corporators of the Boston Five Cents Savings Bank. . . . **Allen F. Grum,** S.M.'58, has been head of the Engineering Department at the West Point Military Academy for two years. . . . **William Sparacin,** S.M.'68, reports that he has been appointed associate of the firm Mueser, Rutledge, Johnston, and DeSimone, consulting engineers, New York City.

Rafael L. Bras, Sc.D.'72, associate professor in the department at M.I.T., has received the Macelwane Award of the American Geophysical Union, in recognition of "his creative introduction of modern statistical methods into the design of networks monitoring rainfall and runoff and into on-line rainfall and river discharge forecasting." . . . **Thomas J. Adler,** Ph.D.'76, an expert on transporation and systems modeling, has been promoted from assistant professor to associate professor in the Engineering Sciences Department at the Thayer School of Engineering at Dartmouth College, Hanover, N.H. . . . **E.L. Bourodimos,** S.M.'66, professor of civil and environmental engineering at Rutgers Unniversity, reports that during the spring of 1981 he was nominated as international consultant in the area of coastal engineering and marine pollution control for the government of India by the Technical Assistance Office of the United Nations Development Program. He assumed the one-month assignment at the Central Water and Power Research Station, Pune, India (the largest applied research laboratory in Asia). Research work and consultations were carried out for four projects in coastal, ocean, and harbor engineering and a condensed advanced course entitled "Hydrodynamics in Coastal Engineering, Marine Pollution and Modeling" was offered to a group of 30 researchers, engineers, and scientists of the Pune Station.

Bertram Berger, '57, a consulting engineer and past director of the Massachusetts Jaycees, passed away on April 4, 1982. He was a member of the Association of Boston Civil Engineers; a past president of the Institute of Transportation Engineering; and a member of the Association of Urban Designers and Environmental Planners.

II

Mechanical Engineering

Ernest B. Gardow, S.M.'58, professor and chairman of the Mechanical Engineering Department at the University of Hartford, Conn., has been re-elected vice-president, Region I (the New England states), of the American Society of Mechanical Engineers. . . . **Don F. Pardo,** S.M.'80, writes, "Presently employed as a mechanical engineer with Gould, Inc., Ocean Systems Divsion, San Diego, Calif., and I recently relocated to Fletcher Hills, Calif." . . . **John V. Mendillo,** S.M.'80, has joined Bell Labs, North Andover, Mass., as a member of the technical staff assigned to the Digital Systems Physical Design Department to work on fiberoptic transmission development.

Joseph C. Batty, Sc.D.'69, is currently a professor of mechanical engineering at Utah State University. . . . **Peter Kalustian,** S.M.'34, writes, "I still continue my international consultation company in the field of food fats and derivatives. During the past year I visited clients in Brazil, Malaysia, Australia, and Canada. I had excellent skiing for over five months—some 52 days of it—in New Jersey, Vermont, and Columbia. It is now motor boating, swimming, and walking with my grandchildren and family. Healthwise, I continue fine." . . . **Sidney A. Whitti,** S.M.'34, reports, "Retired now, but active in the Montana Society of Engineers, including president of the Bozeman Chapter and a state director, and a member of the Manhattan Montana Wildlife Association. My wife and I just returned from her reunion at Smith Collge and we plan to hunt antelope and deer in October and November."

Bertram J. Milleville, S.M.'47, vice-president and senior technical advisor of the Flow Control Division at Rockwell International, Pittsburgh, Penn., has been honored twice—a Fellow by the American Society of Mechanical Engineers (for his engineering achievements and active participation in the society), and election to a three-year term as president of the Manufacturers Standardization Society of the Valve and Fittings Industry.

Harold L. Smith, S.M.'18, of Brandenton, Fla., passed away on March 25, 1982; no details are available. . . . **Edward M. Rex,** S.M.'54, of Northridge, Calif., passed away on April 3, 1980; no details are available. . . . **Jermain F. Rodenhauser,**

S.M.'37, of Clearwater, Fla., passed away on July 8, 1982; no details are available.

III

Materials Science and Engineering

Cyril Stanley Smith, '26, Institute Professor emeritus of the history of technology and science and of metallurgy, was awarded the honorary Doctor of Science degree June 6 at Lehigh University's 114th Commencement. "Combining insights gained through the use of the metallurgist's microscope with those obtained from the historian's research laboratory," the citation read, "Professor Smith has profoundly affected our understanding of important connections between aesthetics and technology."

Philippe P. Delori, S.M.'64, has been named to the new post of manager, international sales, by Sutton Engineering Co., Pittsburgh. He was previously manager of Sutton's office in Brussels. . . . **Thomas A. Schwartz,** S.M.'77, reports that he is developer of the revolutionary Norpine Ski Binding System.

Alan R. Lukens, '41, a well-known chemical engineer and expert on pigments, passed away on June 1, 1982. He was a consultant in the United States and Europe, lecturer; author of many articles on particle size distribution; and inventor of an extender pigment for rubber-based paint and plastic products. He founded Lukens Laboratories, Newton, Mass., in 1944 and owned Skinner Sherman Laboratories, Newton, from 1953 to 1967.

IV

Architecture

Donald Lyndon, former head of the department at M.I.T. who is now teaching at the University of California in Berkeley, is the author of *The City Observed: Boston* (Vintage, 1982). Organized as several walking tours of the city, the book offers Professor Lyndon's descriptions and criticisms of the architecture of more than 300 Boston buildings.

Alan W. Brunken, M.Arch.'63, has been promoted from associate professor of architecture to professor at Oklahoma State University, Stillwater.

V

Chemistry

A. Truman Schwartz, Ph.D.'63, chemistry professor at Macalester College, St. Paul, Minn., was named a national recipient of the 1982 Chemical Manufacturers Association Catalyst Award in recognition of his ability "to instill in students a continuing desire for science education." . . . **Barbara (Van Tassel) Enagonio,** Ph.D.'50, writes, "I am just completing a three-year term as chairperson of the Chemistry Department at Montgomery Community College, Rockville, Md., where I am a professor in the department. I am the mother of seven children—the youngest has just graduated from high school. My eldest daughter, a musician, plays in the Navy Concert Band, Washington, D.C. My eldest son has been teaching math and computer science at the Putney School in Vermont; and my second son is a graduate of the University of Massachusetts, Amherst, in restaurant management. Two sons are still studying engineering (Virgina Tech. and Penn. State); and a daughter is a graduate of Princeton and a graduate student in physics at the University of Colorado, Boulder, and works at Fermilab during summers and vacations."

Mary A.S. Davison, Ph.D.'49, writes, "My husband, **Robert W. Davison,** '50, and I are the grandparents of three grand-daughters and a grandson—Robert Francis Mellen, born in July 1981. In 1981, my husband received his J.D. degree from Delaware Law School and is now a member of the Delaware Bar as well as a research scientist with Hercules, Inc." . . . Two alumni of the department were hired recently by Nepera Chemical Co., Harriman, N.Y.—**David Feitler,** Ph.D.'77, as senior research scientist, and **Larry Nummy,** Ph.D.'80, as research scientist. . . . **Ben A. Tefertiller, Jr.,** Ph.D.'66, laboratory director of Chemical Products and Specialty Products Laboratories, Central Research, has been named director of research and development, Inorganic Chemicals Department, at Dow Chemical U.S.A., Midland, Mich. . . . **William E. Swartz,** Ph.D.'71, has been promoted to the rank of full professor and chairman of the Department of Chemistry at the University of South Florida, Tampa.

Robert N. Bonnett, Ph.D.'40, a consulting engineer, passed away on February 22, 1982. He had operated his own consulting firm since 1974 and previously, was founder and served for 15 years as president of the Bonny Manufacturing Co., Maynard, Mass., makers of Teflon products. He also began the Carolina Industrial Plastics Corp., Mount Airy, N.C. His commercial career began as a chemist in the DuPont rayon plant, Richmond, and he also served as chief of chemistry during World War II at the company's ammunition plant in Denver. . . . **Henry H. Blau,** S.M.'20, of Wayland, Mass., passed away on February 11, 1980; no details are available.

VI

Electrical Engineering and Computer Science

Professor **Wilbur B. Davenport, Jr.,** Sc.D.'50, who was head of the department at M.I.T. from 1974 to 1980 and earlier was director of the Center for Advanced Engineering Study for two years prior to 1974, has retired and moved to Hawaii. Professor Davenport's professional contributions were centered in the fields of probability and random processes, in which he was author or co-author of three important books. He was director of the important research groups in communications and information processing at Lincoln Laboratory from 1951 to 1960, and he returned to Lincoln Laboratory for two years as assistant director in 1963. In the meantime, he had risen to the rank of professor at M.I.T. in 1960, was associate director of RLE from 1961 to 1963 and chairman of the department's Undergraduate Educational Policy Committee from 1968 to 1971.

Mildred S. Dresselhaus, Abby Rockefeller Mauze Professor in the department who is also director of the Center for Materials Science and Engineering, received the honorary degree of Doctor of Science at Hunter College on June 9. "As a woman in a profession traditionally dominated by men," Hunter's citation said, "you have promoted the role of women in science, not only through your example, but through your outspoken and active concern. . . . Your distinguished record of achievement reflects credit on you and on (this) institution where you began your scientific training."

Jose B. Cruz, Jr., S.M.'56, has been elected the 1982 IEEE vice-president for technical activities. . . . **Duane R. Barney,** S.M.'38, writes, "Retired last year after 40 (plus) years with the Bell Telephone Laboratories. Enjoy the freedom to travel and other hobbies. Retirement is great." . . . **John G. Calderone,** S.M.'67, is currently vice-president of the Extel Corp., Northbrook, Ill. . . . **Kenneth W. Exworthy,** S.M.'59, writes, "We have made Marinetti our home. Our present activities include owning and operating Bayshore Marine Electronics, consulting through Exworthy Engineering, and teaching electronics. It's busy, but rewarding." . . . **H. Newton Garber,** Sc.D.'53, is president-elect of the Institute of Management Sciences. . . . **Robert J. Shillman,** Ph.D.'74, has raised $1 million of venture capital to finance his new high-technology company, Cognex Corp., Boston, Mass. The firm will develop, manufacture, and market sophisticated vision systems for industrial automation and robotics applications.

Edward S. Pierson, Sc.D.'60, an engineering educator with research background in energy engineering, has been named head of the Department of Engineering at Purdue University Calumet, Hammond, Ind., and will remain as full professor of electrical engineering. . . . **Barry M. Pressman,** S.M.'67, has joined the Currency Systems Division of Brandt, Inc., Watertown, Wisc., as director of marketing. The division processes equipment for counting currency and other paper items, as well as computerized cash settlement systems used in daily operations of large money volume locations. He was previously associated with Honeywell, Inc., in process management systems. . . . **Howard L. Yudkin,** Ph.D.'59, has been elected a vice-president of Booz, Allen, and Hamilton, Inc., Bethesda, Md. He joins the firm's Communications, Electronics, and Intelligence Division—involved in the area of strategic command, control, and communications.

Robert I. DeSourdes, Jr., S.M.'80, reports, "I am working for Signatron, Inc., Lexington, Mass., as an engineering specialist involved with test design for electronic countermeasure vulnerability assessment of military radio links. In the future, I expect to work in the design of survivable military communications systems and also hope to complete a novel about the rebuilding of American civilization in the post-war environment."

William F. Cassidy, S.M.'43, of Seminole, Fla., passed away on October 21, 1981; no details are available. . . . **Arthur J. Dore,** '41, of Largo, Fla., passed away on February 22, 1982; no details are available. . . . **Roger B. Woodbury,** '48, retired assistant to the president of the Charles Stark Draper Laboratory, Cambridge, Mass., passed away on May 5, 1982. In 1942, he joined the M.I.T. Radiation Laboratory where he aided in designing and developing radar devices for the military services during World War II. Four years later he joined Draper and worked first on design and development of gunfire control systems for aircraft and later on design and development of the laboratory's celestial-inertial guid-

Flemings Named Head of Course III

Professor Merton C. Flemings, '51, who's been a member of the faculty since 1956 and in that period become a key figure in casting research and the teaching of related subjects in materials engineering, is now head of the Department of Materials Science and Engineering. He succeeds Walter S. Owen, who stepped down in September to devote more time to teaching and research.

Professor Flemings was described by Dean Gerald L. Wilson, '61, of the School of Engineering as "a pioneer in the development and teaching of modern materials engineering." Even before 1970 he had made major contributions to solidification science underlying industrial casting and crystal-growing processes, and since then he has extended this work to include new materials not previously available as castings.

Professor Flemings has been director of the Materials Processing Center since 1979, four years after he was named Ford Professor of Engineering. He is the co-author of some 180 professional papers, holds 15 patents, and has written two books in solidification science and foundry technology. Among major awards are the Simson Gold Medal of the American Foundrymen's Society (1961) and the Mathewson Gold Metal (1969) and John Chipman Award (1980) from AIME.

ance system for aircraft. He was later named assistant director and then associate director.

VI-A Program

Course VI will celebrate its 100th anniversary on October 2 and 3—less than a month from when most readers will see this—with a number of special on-campus activities, and we count on the participation of many of this column's readers at these events. Two prepatory workshops in January and June, attended by leaders from various campuses and from industry, laid the groundwork for a day-long symposium on "Long-Term Cooperative Education," dealing with the continuing post-graduate education of engineers in industry. Tours and a banquet will top off the department's celebration.

Starting out as a Course within the Physics Department (called Physics-B) in 1882, electrical engineering came into its own as a department in 1902. The cooperative plan, called Course VI-A, was approved by the faculty in 1907. Due to a depression, however, the General Electric Co. felt it could not put it into operation until 1917 when students from the Class of 1919 were selected to participate at GE's West Lynn Works. The 1907 plan brought only the S.B. degree, but the later-modified 1917 plan, with the graduate thesis at the plant, brought both the S.B. and S.M. degrees which has remained to the present.

TI's annual VI-A luncheon will be history by the time this article appears. It's scheduled for August 19 at the Petroleum Club in Dallas. Begun by **Cecil H. Green,** '23, who will host it again this year, it brings together all of the TI's VI-A students assigned to Dallas and Houston—11 this summer—along with several of TI's vice-presidents and students' managers. Director John Tucker will also attend.

This summer saw another record of VI-A students on West Coast assignments. A total of 41 are working in the San Francisco Bay area at Fairchild, Hewlett-Packard, IBM and Xerox.

During an early July visit, accompanying VI-A Faculty Advisor **Bruce D. Wedlock,** '56, to General Electric Co., Pittsfield, Mass., Mr. Tucker met **Philip O. Martel,** '71, and **Arthur V. Radu,** '77. Both did their VI-A work at GE/ Pittsfield. At GE/Schenectady, later in that same trip, Mr. Tucker met with **Scott E. Cutler,** '72, who took him on a tour of the new R&D facilities nearing completion there. Dr. Cutler is G.E.'s co-ordinator at the Schenectady Research and Development Center.

A surprise visitor to the VI-A Office July 13 was **Karl M. Lofgren,** '75, who is with Western Digital in California. He tells us that wife **Christine (Plapp),** '75, (also a VI-A graduate) plans to attend the University of California at Irvine for further graduate study.

L. James Marggraff, '80, completed his S.M. thesis work at Draper Lab in July and headed west to Santa Clara, Calif., where he will join other M.I.T. alumni working at the Rolm Corp.

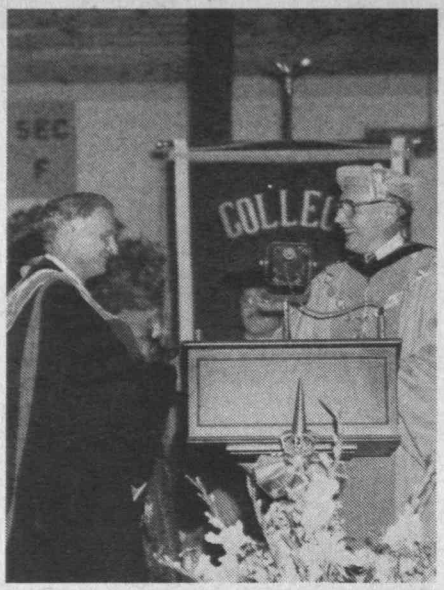
Visitors to the VI-A Office since our last article and in addition to those noted above, have included: **Steven L. Bates,** '74, with GenRad; **William J. Butera,** '81, with Standard Electric Lorenz, Stuttgart, West Germany; **David W. Duehren,** '80, now with Teradyne in Boston; **Charles A. Kaminski,** '70, with his own firm COMMTEH; **Steven D. Krueger,** '79, with TI/Dallas; **Dennis J. Meyers,** '78; and **Karl A. Nyberg,** '80, with Digicomp Research, Ithaca, N.Y.—John A. Tucker, Director, VI-A Program, Room 38-473, Cambridge, MA 02139.

VIII

Physics

Murray Gell-Mann, Ph.D.'51, the Robert Andrews Millikan Professor of Theoretical Physics at Caltech and winner of the 1969 Nobel Prize in physics for his work on the theory of elementary physics, has been named a Fellow at the Los Alamos National Laboratory.

John B. Garrison, Ph.D.'47, on the research staff of the System Planning Corp., Arlington, Va., passed away on November 11, 1981. Formerly, he was employed by APL Research Center, serving as a specialist in missile guidance and radar technology. There he was a leader in the development of the guidance systems for the Terrier and Tartar guided missiles, the widely-deployed anti-aircraft missiles of the U.S. fleet, and was later involved in advanced radar developments. More recently he was on special assignment to the APL biomedical program developing two- and three-dimensional echocardiographic heart-wall-contour monitoring devices.



Congratulations to Arthur B. Metzner (left), Sc.D.'51, professor of chemical engineering at the University of Delaware in Newark, from University President E.A. Trabant. Known for his work in fluid mechanics and related processes, Dr. Metzner received the Francis Alison Award as the outstanding member of the faculty at the university's 133rd commencement exercises last June.

X

Chemical Engineering

Bruce R. Duggar, S.M.'62, writes that he has an additional position as director of the Mid-Atlantic Holding Co., Inc. . . . **Philip M. Gross,** S.M.'63, has been elected a corporate vice-president of the General Electric Co., Fairfield, Conn. . . . **Roger E. Drexel,** Sc.D.'46, has retired from the post of vice-president of E.I. du Pont de Nemours, Wilmington, Del. . . . Two alumni have been re-elected to posts of the National Academy of Sciences—**Frederic A.L. Holloway,** Sc.D.'39, retired vice-president, science and technology, of the Exxon Corp., consultant, and director, has been re-elected to the post of Treasurer (term of 1982-86); and **Ralph Landau,** Sc.D.'41, chairman of the board, the Halcon SD Group, Inc., New York City, has been re-elected to the post of vice-president (term of 1982-84).

Robert W. Davis, S.M.'50, has been appointed president and chief executive officer of Chevron Chemical Co., a subsidiary of the Standard Oil Co. of California. . . . **Roger E. Drexel,** Ph.D.'46, retired on May 31, 1982 from the post of vice-president of the Du Pont Co.'s Polymer Products Department, after a career spanning 38 years. He joined Du Pont in 1944, and much of his career was devoted to agrichemicals research and development; he was the architect of many programs in crop protection chemicals.

Cary J. King, Jr., Sc.D.'58, of Los Altos, Calif., passed away on February 3, 1982; no details are available. . . . **Rosemary J. Wojtowicz,** S.M.'82, a chemical engineer at Air Products and Chemical Co. (since February 15, 1982), Trexeltown, Mass., was killed in a multi-vehicle accident on March 3, 1982 in Allentown, Pa.

XI

Urban Studies and Planning

Professor **David T. Kresge** of Harvard, former director of the M.I.T.-Harvard Joint Center for Urban Studies, sees five dangerous dilemmas for Boston in the near future:

- ☐ A steady demand for relatively unskilled labor but a shrinking supply of entry-level workers.
- ☐ A growing community of middle-level employees expecting traditional rewards for seniority far in excess of available vacancies.
- ☐ Growing numbers of smaller, nontraditional, and affluent households competing for a shrinking supply of appropriate housing.
- ☐ A number of small, innovative businesses interested in locating in Boston but a city policy of seeking established and larger businesses.
- ☐ Growing demands for quality of life—including culture, recreation, entertainment, safety, and transportation—but dwindling resources for providing it.

Without action in these areas, Professor Kresge said, recent efforts to renew Boston's office and hotel facilities will not guarantee economic renewal. "Boston must work to preserve these resources that have come to signify this city's special prominence," he told the "Future Boston" conference last spring.

Ben Bezalel Rosenbloom, M.C.P.'74, formerly city planner for the community redevelopment agency of the city of Los Angeles reports that he is currently associate in the firm (planning and urban design) of Sedway/ Cooke, and project manager for the EIS/EIR for the Los Angeles Metrorail Project (subway starter line), Southern California Rapid Transit District. . . . **William A. Wintz,** S.M.'51, writes, "Retired as professor emeritus of the Civil Engineering Department at Louisiana State University in June 1980. Doing a little consulting engineering—mostly for Barnard and Thomas Engineering, Inc. Have five grandsons and one 'queen' (grand-daughter). Enjoying traveling with my wife along. It has been the first time because we have been raising eight children."

XII

Earth and Planetary Sciences

Professor **Irwin I. Shapiro,** who for more than a decade has been at the forefront in the use of radio and radar techniques to study the planets and test theories of general relativity, has taken a two-year leave of absence from M.I.T. to become director of the Harvard-Smithsonian Center for Astrophysics effective January 1. He has already become Paine Professor of Practical Astronomy at Harvard and a senior scientist of the Smithsonian, and in January, he'll also become director of the Harvard College Observatory and Smithsonian Astrophysical Observatory.

Robert P. Comer, a Ph.D. student in the department, has reported a reconciliation of two methods

for predicting the size and nature of a tsunami (tidal wave) resulting from an undersea earthquake. In one method, vertical motions of the seabed assumed to be associated with a given earthquake are used to calculate the forces driving the water into a tsuanmi; but this method, says Mr. Comer, ignores the elastic nature of the sea floor. A second method includes more fully coupling the water and seabed. Mr. Comer's conclusion: the two methods are in "excellent agreement"; the simpler method is therefore "perfectly valid in practice."

XIII

Ocean Engineering

Albert F. Suchy, S.M.'80, is presently engineering officer of the United States Coast Guard Cutter, Bear (WMEC-901). . . . **C.E. Leising,** S.M.'46, writes from Boiling Springs, Pa.: "Have started overhaul of a micro-hydro plant in a mill race off the Yellow Breeches Creek. The 36-inch Smith turbine—installed in 1917—was last operated in 1953 to generate DC, will be converted to AC and should furnish about 30 kilowatts. . . . **Francisco Fernandez-Gonzalez,** S.M.'66, was appointed professor of ship construction and structures at Madrid's School of Naval Architecture and Engineering in October 1981.

XIV

Economics

Professor **Robert M. Solow** was honored with a Doctor of Law degree at Wesleyan University on June 6. His citation, in part: ". . . As one of the few economists selected to preside over both the American Economic Association and the Econometric Society, and even fewer to be unanimously recommended for any honor by Wesleyan's hard-bitten Economics Department, you are indisputably at the apex of the dismal science . . . You are outspoken in your conviction that the broadened perspective gained from learning how to think like an economist is crucially important to developing an understanding of today's complex world."

Vincent A. Fulmer, S.M.'53, secretary of the M.I.T. Corporation, received an honorary Sc.D. degree from the Florida Institute of Technology early this year, with a citation praising "the many enduring contributions you have made in the advancement of the arts, sciences, economics, urban planning, and social programs by your voluntary participation in organizations dedicated to the betterment of our society . . ."

All his old New England friends came to his support when **George P. Shultz,** Ph.D.'49, was President Ronald Reagan's surprise nominee for secretary of state. "Integrity is a word people always use in connection with George," said Abraham J. Siegel, dean of the Sloan School. Professor E. Cary Brown remembers Dr. Shultz as an "excellent teacher . . . very helpful as a faculty adviser. He was deliberate and thoughtful . . . a very objective and able person." In Cummington, Mass., the Berkshire village where Dr. Shultz summered with his parents as a youth, Brad P. Fisk, owner of the Corners Grocery, remembered: "They couldn't have picked a finer man." And when Dr. Shultz came back to Cummington last summer shortly after he was tapped by the president, Shirley Packard, proshop manager at the Worthington Golf Club, discovered that "he's just one of the guys . . . lots of fun on the course." And then there are those who car-pooled between Stow, Mass., and Cambridge with Dr. Shultz while he was a member of the M.I.T. faculty between 1948 and 1957: ". . . a very knowledgeable person, a very outgoing man," Robert Bird remembers. "He was unflappable," says Thurston Hammer, who's on the staff of Sancta Maria Hospital, Cambridge. "You couldn't rattle him with a whole lot of baloney . . . a very sound person with a good sense of humor, very bright."

Douglas J. Engmann, S.M.'70, has been elected governor, Pacific Stock Exchange (1982); president, Engmann Options, Inc. (1978-82); and commissioner, Board of Appeals for the city and county of San Francisco, Calif.

William J. Dimitrijevic, S.M.'42, of Churchtown, Md., passed away on September 23, 1981; no details are available.

XV

Management

Peter G. W. Keen, associate professor of management science in the Sloan School, is one of 22 contributors to *Communications in the Twenty-First Century*, an anthology based on a symposium sponsored by the Darden School of Business at the University of Virginia (John Wiley & Sons, New York, 1981). In "Telecommunications and Business Policy" Professor Keen notes that without exception communications technology increases abstraction: "Going to work and handling paperwork are concrete, whereas almost every trend in communications contributes to more abstraction. . . . The chief communications planner needs to get ready for a period of complex, challenging change that will affect almost every aspect of the organization."

Professor **Leo B. Moore,** '37, has retired from the teaching staff at the Sloan School after 36 years' service. His goal through this entire period, he says, was "the development of the manager for professional performance at every level of the operational enterprise." Professor Moore was trained in both engineering and management, and his special fields include design, production, and industrial and standards engineering. He has had continuing consulting relationships with a number of firms in personnel administration—especiallly in motivation, leadership, and manpower development through training and education. A high point came in 1960 with the award of Gilbreth Medal by the Society for the Advancement of Management.

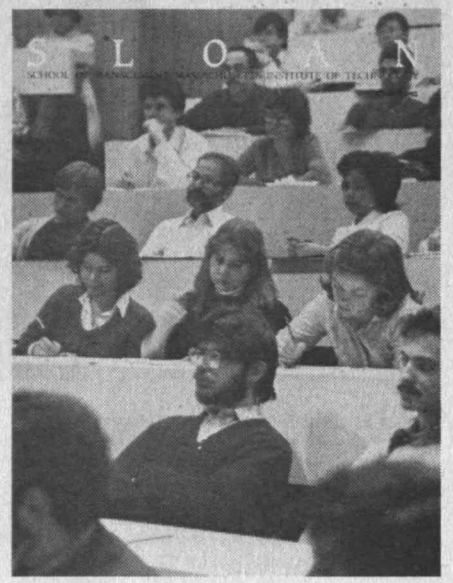
Professor **J. Scott Armstrong,** Ph.D.'68, of the Wharton School (University of Pennsylvania) is general chairperson for the 1983 International Symposium on Forecasting to be held in Philadelphia June 5 through 8. The conference, on forecasting methods and the use of forecasts, may draw more than 1,000 registrants; it's sponsored jointly by the university and the International Institute of Forecasters.

Though it has discontinued the one-year accelerated Master's program in management, the Sloan School is adding new emphasis to the one-year joint Master's program in the management of technology. Its first five students completed their degrees last June just as eight new students entered the accelerated program. It's the first joint advanced degree program between two M.I.T. schools and, according to its director, Professor **Edward B. Roberts,** '57, the first in the country to focus upon managing technological innovation with emphasis on realizing new and improved products and manufacturing processes.

Mark H. Edwards, S.M.'79, has recently joined the Croner Co., a Marin-based human resource consulting firm, as senior consultant. . . . **Jose A. Lopez,** S.M.'72, is presently living in Austin, Tex., and working for NPS Industries as production control manager. . . . **Ejnar Per Sorensen,** S.M.'76, writes, "Still in Pittsburgh, but now with Westinghouse Corp. as a senior consultant in the Planning Department." . . . **Alan M. Cody,** S.M.'74, has been named a senior consultant for Mitchell and Co., Cambridge, Mass., a management consulting company specializing in business strategy at the corporate and individual levels. . . . **David W. Rice,** S.M.'74, has been named vice-president of EG&G, Inc., Wellesley, Mass.

Sloan Fellows

James L. Everett, S.M.'59, president and chief executive officer of the Philadelphia Electric Co., has been elected chairman but retains his duties as chief executive officer. . . . **C. Victor Meyer,** S.M.'67, has been named president of AM Varityper, a division of AM International, Los Angeles, Calif. . . . **William C. Mercer,** S.M.'56, has been promoted from president

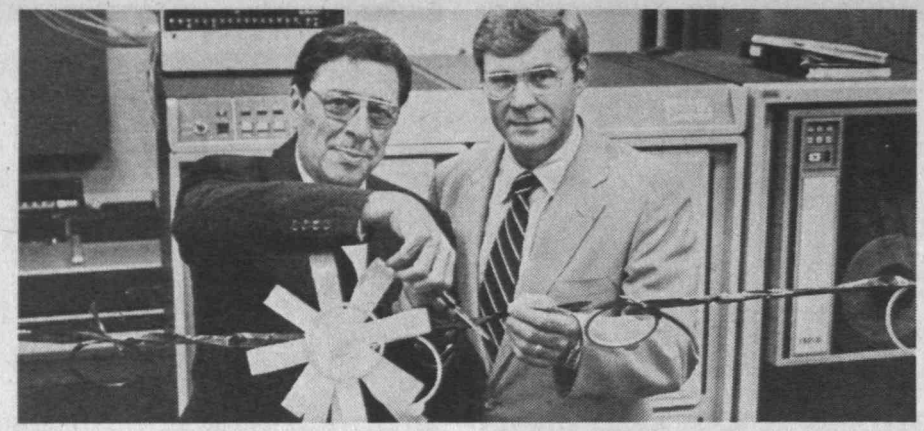


A new bridge-building tool. In the premier issue of Sloan, *a magazine for alumni of the Sloan School's S.M. and Ph.D. programs, Dean Abraham J. Siegel ties improved alumni relations to "building on our legacy of excellence."*

Sloans Receive *Sloan*

Sloan Magazine, a new venture in alumni relations for the Sloan School of Management, is described by Professor Abraham J. Siegel, dean of the School, as "step 4 in a recently launched bridge-building mission" whose goal is "improved linkages and communication . . . with our alumni and alumnae."

Published twice a year, *Sloan* will supplement the coverage of school affairs in the "Courses" section of M.I.T.'s alumni magazine, *Technology Review*. In addition to regular coverage of faculty and student activities, says Paula Cronin, S.M.'74, editor, there will be reports by faculty and alumni on their professional work and announcements of coming events in Dean Siegel's "bridge-building" effort. Already, says Dean Siegel, "we are all today a lot closer than we have been in a long while, and I hold very dear the exchange of viewpoints and help."



Cutting the ribbon on a new Prime. A new Prime 850 now replaces the Prime 400 in use in the Sloan Building since 1978, and to celebrate its arrival Dean Abraham J. Siegel (left) of the Sloan School invited Joseph M. Henson, president of Prime, to join in this ribbon-cutting ceremony late last spring. The new machine significantly increases the computing power available to the Sloan School and the Departments of Economics and Political Science; to make that point, there was free computing service for 24 hours when the Prime 850 went on line.

of New England Telephone and Telegraph Co., to become its chairman and chief executive officer until his retirement on October 31.

Robert S. Ames, S.M.'54, executive vice-president of Textron, Inc., Bellevue, Mass., was elected a director.

Senior Executives

James F. Roth, '73, has been recently elected to membership in the National Academy of Engineering. . . . **David S. Hollingsworth,** '70, vice-president of planning for Hercules, Inc., Wilmington, Del., has been elected a director of this chemicals and plastic firm. . . . **Louis Castelli,** '67, president of Moore McCormack Energy, has been elected vice-president of Moore McCormack Resources, Inc., a transportation and natural resources concern.

Cornelius G. Zwart, '61, has been appointed director of international field operations for RCA'a Government Systems Division, Washington, D.C., responsible for worldwide marketing and distribution of the division's products.

XVI

Aeronautics and Astronautics

Robert C. Seamans, Jr., Sc.D.'51, who is now Henry R. Luce Professor of Environment and Public Policy in the School of Engineering at M.I.T., was honored with a degree of Doctor of Humane Letters at Curry College, Milton, Mass., in June. He was cited as a "consistent advocate of a strong national defense posture" and honored "for your creative contributions to the nation and for exemplifying that distinguished, uniquely American interdependence which has so long existed at high levels between the academic world, public service, and corporate enterprise."

Raymond L. Bisplinghoff, former head of the department who went on to be dean of the School of Engineering before leaving M.I.T. to be chancellor of the University of Missouri at Rolla, now holds the Elder Statesman of Aviation Award of the National Aeronautics Association.

Alfred Menendez, S.M.'81, reports, "I am presently residing in Cocoa Beach, Fla., and am working at the Kennedy Space Center for Rockwell International as a guidance and navigation systems engineer on the Space Shuttle. I operated the guidance and navigation console for the third launch of the 'Columbia.' It was an unforgettable moment which I hope to repeat many times in the future." . . . **Edwin N. Myers,** S.M.'61, reports that he is senior member, technical staff, of Eagle Research Group, Arlington, Mass.; a consultant at the Institute for Defense Analysis; an expert on high technology export to the DOD, State, Commerce and DOE; and retired from senior executive service in 1980 as director of electronics, Office of the Undersecretary of Defense Research and Engineering.

Arthur J. Wennerstrom, S.M.'58, has been named a Fellow of the AIAA and of the ASME in 1981. . . . **John F. McCarthy, Jr.,** S.M.'50, has been named vice-president and general manager for the Northop Corp.'s Electro-Mechanical Division, Anaheim, Calif. . . . **Courtland D. Perkins,** S.M.'41, has been re-elected to the post of president of the National Academy of Engineering for the term 1982-83.

George C. Grogan, Jr., S.M.'48, of Camarillo, Calif., passed away in December 1981; no details are available.

XVII

Political Science

Two members of the department at M.I.T. were given honorary degrees last June—Professor **Walter Dean Burnham** at Rutgers University on May 26 and Professor **Lucian W. Pye** at Carleton College on June 12. Professor Burnham was cited for his Doctor of Letters degree as "an insightful chronicler of the American party system, as a distinguished prophet of the effects of political disaggregation on democratic institutions, and as a trenchant critic of the power of the unbridled elites in a pluralistic society . . ." For his Doctor of Law degree, Professor Pye was cited by his alma mater: "As he has improved our understanding of Chinese politics through the use of psychological and anthropolitical approaches, so he has used his knowledge of the Orient to extend and refine Western social science. His work represents the integration of different approaches and subject matter that we strive so hard to attain in liberal arts."

Professor **Robert I. Rotberg** of M.I.T. and Miles F. Shore of Harvard Medical School are recipients of a major, multi-year grant from the Research Division of the National Endowment for the Humanities to write a biography of Cecil J. Rhodes, the British-born imperialist and mining entrepreneur whose name is also given to the prestigious scholarships for study at Oxford. Professor Rotberg is a specialist in the history of politics of southern Africa.

XXI

Humanities

Leo Marx, William R. Kenan Professor of American Cultural History in the M.I.T. Program in Science, Technology, and Society, was commencement speaker at the College of the Atlantic, Bar Harbor, Maine, early in June.

One of those telephone calls most of us just dream about: **Charles F. Sabel,** Ford International Assistant Professor of Social Science in the Program on Science, Technology, and Society, received as a complete surprise late last June a $35,000 three-year award of the John D. and Catherine MacArthur Foundation. The foundation's idea is to identify "exceptional" talent and then release it so that recipients can "cultivate what they feel is most vital to them and to contribute that to all of us," says the program director. Professor Sabel will use his award for continued studies of the sociology of the labor market.

XXII

Nuclear Engineering

Professor **Manson Benedict,** Ph.D.'35, former head of the department who now holds the rank of professor emeritus, released a statement early in June proposing that the liquid metal fast breeder reactor "is the best prospect the United States has for nuclear power generation after our limited resources of low-cost natural uranium are used up. . . . The Clinch River Breeder Reactor," he wrote, "is the next logical step in a series of progressively larger breeder reactors which have been built in the United States. We should make (its) completion . . . a major national objective."

Edward R. Chow, S.M.'69, writes, "I have recently taken over as chief operating officer of Stevia Co., a high-tech company developing a natural non-caloric sugar substitute. You'll hear much more about us in the next few years. Being in business for myself is a lot of fun—and hard work. But my engineering degree from M.I.T. and my subsequent M.B.A. from the University of Chicago ('73) have prepared me very well." . . . **Tatsujiro Suzuki,** S.M.'79, reports, "The International Energy Forum (IEF—founded in 1980) is an independent research organization, specializing in energy policy and international affairs. I joined the firm in February 1981, as a supporting staff/senior researcher, and am currently engaged in a projected entitled "alternative strategies for the commercial introduction of nuclear power technologies in Japan."

R. Anthony Shober, Ph.D.'77, is presently staff supervisor with the American Telephone and Telegraph Co. Long Lines Department.

Technology and Policy Program

David Hanrahan, '79, is at Binnie and Partners, Melbourne, Australia, responsible for a major plan to reorganize and finance 437 water authorities in the state of Victoria. He recently went on a round-the-world trip and visited TPP alumni **Dick Kutta, Rick Hornby,** and **Shashi Sharma.**

Michael Karma, '80, is completing his M.B.A. degree at Harvard and does freelance consulting in software. He and his wife, Linda, were married in 1981 and are living in Boston. . . . **Michael Poulsen,** '82, is working for Stanford Research Institute as a molecular theorist and is living in Menlo Park, Calif. . . . **Shunichi Kometani,** '82, is working in the Technical Administration Division of Yamaha Motor Co., Ltd., Shizuoka, Japan. . . . **Jon Zilber,** a master's student in the program, spent last summer as a member of the staff of the *Richmond News Leader* under a Mass Media Science Fellowship awarded by the AAAS. Mr. Zilber says he hopes to pursue a career which would "promote public understanding of the benefits, dangers, and limitations of science and technology."—Professor Richard de Neufville, Chairman, Room 1-138, M.I.T., Cambridge, MA 02139.

Classes

Celebrating his 100th birthday on February 28, 1982, ***Ichabod F. Atwood, '03****, lives with his wife Gertrude in Topsfield, Mass. After graduating from M.I.T. in mechanical engineering, Mr. Atwood was associated with the Atwood and McManus Box Co., founded by his father. In 1954, he was named president of the Chelsea Savings Bank and later served as chairman of the board.*

In addition to his professional accomplishments, Mr. Atwood has traveled around the world three times, is an enthusiastic photographer, past president of the Chelsea Rotary Club, a director of the Topsfield Historical Society, and a member of the Topsifeld Congregational Church. He also managed to catch the largest salmon ever caught at the Tabusintac Fishing Club in New Brunswick, Canada. (Photo: Tri-Town Transcript)

12

Kenneth C. Robinson of Salem, Ore., passed away recently. He received his degree in mechanical engineering and taught this subject at both Harvard University and Lowell Institute. As an undergraduate at M.I.T., Kenneth was involved in the Mechanical Engineering Society, the Glee Club, the Tech Show and Class football. His son, Richard F. Robinson of Portland, Ore., wrote to tell of Kenneth's death and added, "My first memory of M.I.T. was when I was about 4 years old (around 1919) and Dad took me along when he visited the Steam Lab, then in Building 3. Dad later remarked that my head swiveled so fast he thought it would come off!"

We send our heartfelt sympathy to the family.—*ed.*

13 65th Reunion

Not much to report and I wondered about Technology Day, so I called **Walt Muther**. I had the pleasure of talking with his grandson, and then with Walter. He sounded about as young and chipper as the grandson. He reports that he and **Warren Glancy** attended the luncheon on Technology Day (the only two '13ers). These two certainly merit a lot of praise for their faithful attendance over the years. Walt also said he is still gardening, but like most of us, he's frustrated because he couldn't get his corn planted early on account of the wet, cold spring.

We have been advised by the Alumni Office of the death of **Cedric Burgher**. "Cedric Burgher, 92, former president of United Fidelity Life Insurance Co., died at his North Dallas Home on March 16, 1982. Born in Honey Grove, Fannin County, Burgher attended the University of Texas at Austin from 1908 to 1910 and Cornell University in Ithaca, N.Y., from 1910 to 1911. He graduated from M.I.T. in 1913 with a degree in mechanical engineering. During World War I, Burgher served as captain in the U.S. Army Ordnance Corps, Engineering Branch, serving a year in France in the American Expeditionary Force. Burgher was owner and president of Cedric Burgher Construction Co., which he established in the mid-1920s. He had been associated with United Fidelity since its organization in 1920, serving as a member of the board and the executive and investment committees. Burgher was elected vice-president of United Fidelity in 1948. He was named president in 1955 and chairman of the board in 1961. He retired in the mid-1970s but retained the title of chairman emeritus. He was a Mason and a member of the York Rite Dallas Templar No. 6. He was a member of the City Club, Dallas Country Club, Dallas Historic Society, Phi Delta Theta fraternity and Highland Park United Methodist Church, where he was a trustee and member of the board of stewards. He is survived by his wife, Frances, two sons, two daughters, 14 grandchildren and two great-grandchildren." Good harvesting.—**Rosalind R. Capen**, Assistant Secretary and Treasurer, 7 Brackett Point Rd., Biddeford, ME 04005

Warren Glancy, '13, and Walter Muther, '13, the two oldest alumni present at the Technology Day Luncheon, pose in front of the Student Center. (Photo: Scott Globus, '84)

14

Harold A. Mayer, whose death on February 3, 1982, was reported in the August/September class notes, was with us in all four years and at graduation. His S.B. degree was in electrochemical engineering. He spent most of his life in Portland, Ore., but lived briefly in California in 1915 and again for a few years in the early 1920s. In the 1930s he lived for several years in White Rock, British Columbia. Harold was a descendant of John Wolf, a pioneer and early boat captain on the Columbia River. During most of his adult life Harold taught mathematics in high schools in the Portland area. One of his accomplishments was a collection of American Indian baskets and other artifacts which his mother had started at the turn of the century. Harold continued it, acquiring many handsome pieces. In 1972 he gave the entire collection to the Northwest Indian Center in Spokane, Wash., where it is now displayed and preserves his memory. Harold is survived by a son, Dr. Dennis O. Mayer, of Milwaukee, Ore., who kindly supplied most of the information for this note.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, CT 06119

15

Greetings to all 1915 Class Supreme Alumni! Just as you continue to be loyal to the M.I.T. Alumni Fund, the Institute itself, and to each other, I hope you will write me, filling me in on any news which can be included in *Technology Review*. Through working with all of you, I am fully aware of how much you like your class to be included in the class notes section, so with your individual participation, by keeping in touch with me, we can have continuous write-ups.

At Technology Day in June, **Evers Burton** seems to have been our only representative. . . . Just talked to Pop or **Carl Wood** on the phone; he has had a heart attack and three operations, but at present is physically doing well indeed. He is recuperating nicely and his wife, Charlotte, is doing a great job taking tender loving care of him and their new dog. He is getting out and about again, and wanted me to say hello to everyone. . . . Had a nice letter from **Fred Vogel**, who lives in Clearwater, Fla., and he and his wife, Mary, are carrying on after 56 years of married life. Unfortunately, however, she is not too well. . . . Every year I hear from Amy Ford Stearns, widow of **Edmund R. Stearns**, and she is very active. She went to the Annual New England Congress Convention at Fairlee, Vt., and saw Mary or **Mimi Plummer Rice**, who also attended. At this gathering Amy was given a Certificate of Award (which was a real surprise) for fifty years of continuing service to the National Society. She then went to her reunion at Smith College, in Northampton, Mass., and was made a Sophia Smith Scholar—another lovely surprise. She feels she has weathered the years extremely well and her answer is: keep active! . . . **Mimi Plummer Rice** is still going strong. Before attending the New England Congress Convention she spent some time with her son in Puerto Rico and by now she is back in California.. . . I talked to **George Easter**, who lives in West Seneca, N.Y., and who spent the winter in Florida. For the last five summers George has gone on an extended trip. Last year he traveled to New Zealand and Australia, and had a wonderful time.

Sad news to have to report that **Alton A. Cook**, a very active alumnus, passed away. His son informed the Institute that he had attended sixty Alumni gatherings.

Fiske R. Jones, 91, passed away on February 4, 1982. He was a plant engineer for Simonds Saw and Steel Co., in Fitchburg, Mass., before his retirement. . . . Each one of you knows how proud I am of the classmates of the Class Supreme. Thanks very much for your participation in the 1982 Alumni Fund. Through my personal contact with you, I am fully aware that you delight in having class notes in *Technology Review*. So the one and only successful way to have them appear is by KEEPING IN TOUCH WITH ME!—**Joyce E. Brado**, Class Agent, 491 Davison Rd., Apt. 9, Lockport, NY 14094

16

We enjoyed a delightful class reunion luncheon at Page's Colonial Inn in Wakefield, Mass. on Wednesday, June 16th. Here is a list of those who attended: Frieda and **Hy Ullian**; Frances and **Paul Duff** with their son, Dr. John Duff and his wife, Estermarie; Frances and **Henry Shepard**; Grace and **Dan Comiskey**; **Nat Warshaw**; **Barney Gordon**; **Doug Robertson**; **Bob O'Brien**; Anne and **Izzy Richmond**; Sibyl and **Ralph Fletcher**. Everyone seemed to be doing well. We enthusiastically shared reminiscences of days of old plus what's been happening in recent months. Ralph announced that Barney Gordon had graciously accepted the responsibility of being our Class Agent. Dr. John Duff was active with his camera taking candid shots throughout the afternoon. Barney added a real touch of class with his inimitable rendition of "Old Man River," which is a rich tradition of our class gatherings. "Old Man River" is the theme song for our class, and Barney is the official singer for our class.

We regret to report the death of **Cy Guething.** His son, Ted Guething, '41, wrote to say that his father "stopped breathing" peacefully and in good spirits on June 22, 1982, and that he loved his classmates. . . . I had a nice card from **Nat Warshaw** who was vacationing in Derby, Vt. He wrote: "It was a wonderful treat to be with you all.". . . Anne and **Izzy Richmond** wrote: "Glad to see you all at the luncheon. Class of '16 is still, to quote you, the B.D.C.T.E.G.R.M.I.T. Truly remarkable. . . . Frances and **Henry Shepard** wrote: "It was an enjoyable party. The location was easy to reach. The food was excellent and I was so glad to see so many there."

Don Webster wrote: "So sorry not to be with you for luncheon on June 16. Since a broken hip last June, I have been using a walker to get about. Mobility is restricted and I haven't been out of Falmouth since then. My best to all. Half-way through my 88th." . . . **Fred Kenny** of Templeton, Mass. called to thank us for inviting him to attend the luncheon but couldn't attend. . . . **Gerstle Mack** wrote in part: "I regret that I shall not be able to be present. At 88 I'm still ambulatory but it isn't so easy for me to gad about. Moreover I wouldn't know any of the group. My own graduate year at M.I.T. was so concentrated on our little group of ten architectural students that I had no time to make friends or even acquaintances outside of that restricted circle. So I would be a stranger at the luncheon with little in common with my companions. Best wishes for the success of the reunion."

George Crowell missed his first reunion in many years and wrote: "I am sorry I won't be able to make the luncheon on June 16th. Please give my best regards to the classmates attending." . . . **Joel Connolly** wrote: "I do not expect to attend our class reunion—Virginia is in a nursing home here in Tucson and I don't want to leave her. Thank you for all you have done and are now doing for us. When you come to Tucson again we hope to see both you and your wife." . . . **Charles "Mac" McCarthy** wrote: "In response to your recent letter I regret to have to say that Betty and I will be unable to attend the class luncheon. It does have a lot of attraction and we hope that many classmates will be able to come. Betty joins me in sending our best wishes to you, Sibyl and other old friends who are able to attend." . . . We also received "Sorry, can't make it" letters from **Val Ellicott** and **George Ousler**.

We regret to report the death of our classmate, **Howard T. Evans**, on June 19. He retired from Stone and Webster Engineering Corp. in 1959. He was a commander in the Navy in World War II.

Keep eating, drinking, walking, breathing, everything in moderation, and yes, of course, keep writing.—**Ralph A. Fletcher**, Acting Secretary, West Chelmsford, MA 01863

17

Our 65th Reunion was held in Cambridge in June and was enjoyed very much by those able to attend. Attendees were 11 members of the Class with five wives (**Walt Beadle** and wife, **Ray Brooks**, **Penn Brooks**, **Leslie Christison**, **Stan Dunning** and wife, **Osgood Holt**, **Ken Lane** and wife, **Stan Lane** and wife, **Alvah Moody**, **Will Neuberg** and wife, and **Tubby Strout**) and five honorary members (**Conchita Lobdell Pearson**, **Jay** and **Kay Stratton**, and **Don** and **Phyl Severance**). **Osgood Holt** from California traveled the longest distance to get to Cambridge; and the runner up was Conchita from Mexico. Of the surviving members of our Class, 75 were unable to attend the Reunion. An example was **Leon Keach** of Melrose Highlands, Mass., who wrote recently that he was able to be about, "but, for exercise, a mole hill in the back yard has supplanted the white hills of New Hampshire."

The Reunion began with checking in at McCormick Hall on Wednesday afternoon, June 9. Then a shuttlebus took us to the Faculty Club where we had dinner in a private dining room. After dinner we were serenaded by the M.I.T. "Chorallaries" singing group. . . . On Thursday we were taken by shuttlebus to the M.I.T. Museum and Historical Collections, which we found well worth visiting and where we had a special luncheon. That evening, instead of attending Tech Night at the Pops, which we felt might be too strenuous for some of us, we went by bus to Endicott House in Dedham. There we had a special dinner, followed by an excellent piano concert given by Mildred Lane, wife of **Stan Lane**.

Friday was Technology Day. We were able to attend any meeting of our individual choice, including a memorial service in the Chapel and the Alumni Luncheon in the newly completed Athletic and Special Events Center. The Reunion ended with a late afternoon Technology Day reception in McCormick Hall for all alumni.

In June, Pat Erb wrote us that, in memory of her husband **Bob Erb**, nine lovely specimen trees had been planted at the New Canaan Nature Center as an enlargement of the arboretum of specimen trees already there. She said this was made possible by the gifts they had received when Bob died.—**Walter J. Beadle**, Secretary, Kendal at Longwood, Box 217, Kennett Square, PA 19348

18 65th Reunion

It is midsummer and there is a dearth of news to report. The annual gathering of alumni in early June (reported in other columns of this issue) included only **Eli Beruan**, Selma, and myself to represent 1918. Next year—our 65th—represents a challenge to all of you to make a special effort to come to Cambridge to make it an outstanding ocassion—one that will bring much pleasure to all of you to renew

the friendships of these many years.

The June 13th issue of the *Boston Globe* noted the following: "Two late Boston housing personalities connected with home building for many years were among 16 national housing leaders inducted into the Housing Hall of Fame in Washington recently. The honors locally went to John H. Fahey of Boston, who died in 1960, and architect **Royal Barry Wills** of Boston, who died in 1962. Wills specialized in designing single-family homes and wrote six best selling books and numerous magazine articles that helped stimulate interest in simple American home design. The label 'a Royal Barry Wills Home' became a sign of distinction. He won the Herbert Hoover Medal and other national honors for his work and was named Fellow of the American Institute of Architects. The honors were announced at the recent spring meeting for builders and directors of the National Association of Home Builders (NAHB). Plaques containing a likeness of each individual cited are permanently mounted in the National Housing Center in Washington operated by NAHB. The Housing Hall of Fame is sponsored by the National Housing Center Board of Governors."

John Abrams sent me his check for the Alumni Fund with the following comment in his cover letter: "Wells Bosworth, '89, was a longtime friend of our family. His estate in Paris environs was 'Marietta,' his boyhood home in Ohio where my mother knew him many years ago. He visited us in L.A., perpetuating old friendships."

I note with sadness the passing of **Stanley Leonard** as recorded in the following item from the *Laconia Citizen*: "Chickadees and grosbeaks, woodpeckers and bluebirds, feathered creatures in general, lost a good friend this week in the passing of Stanley Leonard. And Sanbornton lost a concerned environmentalist whose interest in nature spanned a lifetime. Supervisor of exams and registrar of summer school of Harvard University for more than 40 years, Stanley and his wife, Florence, have had a home in Sanbornton since 1931. A good neighbor and an exceedingly witty gentleman, Stanley would ocassionally write a letter about happenings around the bird feeders and lilac outside the Leonards' kitchen window that would be a masterpiece. One saved the epistle for future enjoyment. Photography was a hobby. Bay neighbors cherished his black and white studies of their children with a farm animal or pet. Perhaps the finest memorial to Stanley is a book, *Skyline Promenades* by Brooks Atkinson, Pulitizer Prize winner and longtime drama critic for the *New York Times*. *Skyline Promenades* relates a 1924 summer adventure of Brooks and his friend, Stanley, to whom he refers as Pierre in the book. Equipped with backpacks holding provisions, gear and a book of Socrates to be read aloud when their own philosophical debates needed a third party, the two young men left North Station, Boston, on a Sunday morning for a fortnight in the wild. The train deposited them at Madison Station for Chocorua, their first mountain climbing of the trek which let the pair to Mount Washington and back. The book, published first in 1925 by Alfred Knopf, was reprinted in part a few years ago in a magnificent volume, beautifully illustrated, *New England's White Mountains: A Home In the Wild*. The newest volume was published by the Appalachian Mountain Club/New York Graphic Society and Boston Friends of the Earth in San Francisco, London and Paris and is available at the Laconia Public Library."—**Max Seltzer**, Secretary, 1443 Beacon St., Brookline, MA 02146 and **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Brookline, MA 02146

19

Uppermost in our minds as we write these notes are plans for our Class of 1919 reunion in 1984. The entire class of 94 classmates were contacted and at this writing in July there are 35 replies and 17 give some evidence of planning attendance, 10 with their wives. More replies are expected and we are optimistic that this reunion is assured. I hope you will be among those who come to what may be our last such reunion.

The Class of 1917 gather for their 65th Reunion picture in Compton Gallery in front of an oil painting of the Rogers Building on Boylston Street by Nelson Chase, '17. The painting was a 50th Reunion gift from the 1917 widows. Seated in the front row (left to right) are Mildred Lane, Stanley Lane, Jeannette Dunning, Stan Dunning, Henry Strout, and Ray Brooks. Included in the back row are Christine Beadle, Walter Beadle, Kenneth Lane, Betty Lane, Alice Neuberg, Conchita Lobdell Pearson, Osgood Holt; and standing are Donald Severance (left) and William Neuberg. (Photo: John Mattill)

The class poll revealed the decease of **Nelson A. Bond** on July 26, 1981; **Hosmer C. Jones** on January 17, 1979; **Lansing M. Quick** in July 1979; and **James C. Sansberry** on January 12, 1981. We regret reporting the deaths of these classmates without more details.

Most of the responses to date contain some comment that I take pleasure to pass on to you. **Milton A. Loucks** says he is "feeling fair but is very calendar conscious!!!" . . . **George B. Hirsch** writes that he is "pretty good," but reminds that "at our ages, two years is a long time." . . . **Rusell S. Palmer** says he is "in good but not perfect condition—working on improvement.". . . **Francis Wieskittel** sends a card marked, "Don't regret growing old. It is a privilege denied to many.". . . **Leon Snow** writes that he is "great," and **Lester Wolfe** writes that he is "fine." . . . **Larry Riegel** replies, "My health is good, I enjoy life, exercise by gardening and by walking my dog several times a day *every* day."

Don Way, our Class President, has appointed **Royden L. Burbank** as our Class Agent to serve with **Dan K. Webster** who has been our Agent for several years. To return to the 1984 Reunion, the choice of location seems to be the Hyatt Regency in Cambridge, Mass. Your Reunion Committee of Michelson, Way, Doten and Flynn will assist the writer in working out the details and posting you. So let's be young again and plan now to attend and enjoy a last but not least reunion with our classmates and their ladies.—**W.O. Langille**, Secretary, Box 144, Gladstone, NJ 07934

20

Technology Day turned out to be a very pleasant occasion for the class. Present were Betty and **Norrie Abbott**, **Al Burke**, Pat and **Buzz Burroughs**, Mina and **Perk Bugbee**, Kay and **Frank Maconi**, **Ed Ryer**, **Phil Wait**, **Elbridge Wason** and his charming daughter, Barbara Drew. A very good turnout which augurs well for our 65th in '85.

Word has reached us of the death of **Bob Pollock** on April 28 last year. Bob lived at 1940 Jefferson Drive, Pasadena, Calif. He put in a lifetime of service with Southern California Edison Co. as supervising electrical engineer. He is survived by his widow, Marjorie, a son and daughter, three grandsons and three granddaughters. . . . **John Visscher** of 90 Lindall St., Danvers, Mass. died on April 19. He had lived in Springfield, Waterburg, Conn. and Pawtucket prior to moving to North Andover in 1973. John was a self-employed mechanical engineer for many years and later was connected with Frain Corp. in Providence. He is survived by a daughter, four grandchildren and one great-grandson. He was a member of the Massachusetts Society of Professional Engineers and American Society of Tool Engineers, an expert amateur photographer and student of wild life.

A welcome letter from **Al Burke**, the indefatigable tennis player, contains the good news that he will soon resume tennis operations after his operation last spring, a fact that we must all admire. Al says, "As to Wimbledon, I expect to see McEnroe win but I would be perfectly happy to see it go to Jimmy Connors." Glad you got your wish, Al.—**Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, MA 01890

21

Twice a year the news deadline seems to fall within vacation periods and, alas, this is one of those times. Your secretary is at Squam Lake, N.H., where two summers ago "Golden Pond" was being shot. Today is a gray day with rain threatened and no sparkle on the lake, so it's a good day to write class notes.

Assistant secretary **Josh Crosby** sends a folder covering memorial services for **Thomas D. Dutton** of Austin, Tex., who died on May 25, 1982. The services were held in Sarasota, Fla., where Tom lived for many years following retirement. Josh and **Whittier Spaulding** attended the services. Tom Dutton spent a large part of his business career with AT&T Long Lines Department as division plant supervisor.

Earl Eacker, '22, and D.F. Carpenter, '22, exchange enthusiastic reunion greetings. (Photo: Scott Globus, '84)

Josh also told of seeing **Herb Kaufmann** but said Herb wasn't getting out very much because of back trouble. Claudia Crosby is having rheumatics and temporal arteritis (muscle pain and stiffness) but Josh hopes they can get up to Maine for part of the summer.

Emma (Mrs. **Leon A.**) **Lloyd** sent me a note she had received from Anne (Mrs. **Wallace**) **Adams** telling of Wally's being in a convalescent home. Wally had a hip replacement in April followed by further surgery, so he experienced great difficulty walking. We hope you will be home soon, Wally! Anne also told of phoning Elma (Mrs. **John**) **Mattson** right after Christmas and learned that all was well with her and that she still lived in Winthrop, Mass. The Lloyds visited their daughter Barbara Hayes in Westwood, Mass., and while there, Winnie Wood Foss (widow of **Royal Wood**) came over for lunch. Winnie is doing fine and she and the Lloyds reminisced about old times together. Emma Lloyd just had a reunion at Wheaton and reports that she and Al had a first floor room and private bath. Says she, "Even McCormick Hall didn't have that luxury."

Two postcards from **Bob Miller** and a letter from **Cac Clarke** reported on Technology Day this year. The Clarkes picked up Helen (Mrs. **Raymond A.**) **St. Laurent** in Manchester, Conn., on their way to Cambridge. At the annual luncheon, the 1921 table included **Donald Morse**, Helen and **Bob Miller**, Helen St. Laurent, **Frank Whelan**, Maxine and **Cac Clarke**, and Diana and Hugh Darden. Most of those in the group attended the Memorial Services in the M.I.T. Chapel. Leaving Cambridge, the Millers headed north for a tour of New Hampshire and Vermont and then planned to swing west into New York State and Pennsylvania on their return home to Silver Spring, Md. Bob Miller reported on an M.I.T. luncheon he attended at Orleans, Mass., which included, among others, **Don McGuire** and **Whitney Wetherell**.

In addition to the death of Tom Dutton reported above, I have been notified of three other deaths: **Walter J. Hamburger** of Dover, Mass., on January 18, 1982; **Samuel T. Drew** of Miami Springs, Fla., on April 26, 1982; and **Carolus L. Eksergian** of Stillwater, Penn., on May 22, 1982. Walter Hamburger had a distinguished career in the teaching field which included lecturing on textile research at M.I.T. and at Simmons College. He was professor of polymer mechanics at the Polytechnic Institute of Brooklyn and a visiting professor at Lowell Technological Institute. He served as a member of the Board of Directors of the Lowell Institute Research Foundation and vice-president of the Textile Institute of Manchester, England. He was the author of many publications and received numerous awards and honorary degrees. . . . Samuel Drew served as chief of the Division of Health and Sanitation at the American Embassy in Guatemala and later in his career as sanitary engineer for the Reader Engineering Co. in Miami, Fla. . . . Carolus Eksergian was a mechanical engineer working in Detroit for the Budd Wheel Co. and later for Kelsey-Hayes Co. in Philadelphia. He received many patents on brakes and wheels. During World War II he was the civil head of the federal government's rocket and guided missile commission.—**Sumner Hayward**, Secretary, 224 Richard Rd., Ridgewood, NJ 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, FL 33579; **Samuel E. Lunden**, Assistant Secretary, 1149 S. Broadway, Suite B-800, Los Angeles, CA 90015

22

Our 60th Reunion in Cambridge on June 9–12 was favored with the return of good weather after a soggy weekend that flooded many parts of New England. The starting line up on Wednesday included: Madeline and **Parke Appel**; Jenette and **Ray Burrus**; **Don Carpenter**; **Yard Chittick**; Marion and **Saul Copelman**; Ella and **Robert Cummings**; Carroll and **Bertha Dodge**; Peter and **Earl Eacker**; Aline and **Ray Ellis**; Hazel and **Ed Fales**; **Lawrence Gentleman**; Mary and **Oscar Horovitz**; **Ab Johnson** and daughter, Joanne; Geraldine and **Ed Keane**; Carlys and **Frank Kurtz**; **Ed Koehler**; **Roger Ingalls**; Foong Soong Jen and **Zen Zuh Li**; **Lachlan Mackenzie**; Vickie and **Ed Merrill**; **Martha Eiseman Munzer**; **Marjorie Pierce**; Tony and **Win Potter**; **Allen Reinhardt**; **Sam Reynolds**; **Frank Rickers**; **Walt Saunders**; Clara and **Al Silverman**; **Van Dorn Smith**; Anna and **Randall Spalding**; Marian and **Roy Stone**; **Bill Stose**; Dotty and **Sam Zack**. Subsequent arrivals were Fanny and **Randy Myer**, **Dave Harris** and his wife, **John Strieder**, Louise and **Ted Elliott** and Catherine and **John Goodnow**.

At our opening dinner on Wednesday at the Faculty Club, President Paul Gray spoke of the tremendous impact the establishment of the 1922 Professorship has had at the Institute. By the end of John Wulff's tenure, the feeling had spread through the faculty that appointment to the 1922 Professorship was to be considered an important step up, carrying unusual prestige endowed by the uniqueness of the chair. When Paul Gray, studying in North Wales at the time, received a telegram from Gordon Brown—then dean of engineering—asking if he would accept the post as the second incumbent, he was overjoyed. Since then, the Professorship (Wulff, Gray, Lamson and now Mattuck) has steadily increased in significance aided by the addition of the career development posts also funded by the class. President Gray affirmed that the Class of 1922 has good reason to be proud of what its generosity in 1962 and thereafter has accomplished. On Thursday we enjoyed lunch at M.I.T.'s beautiful Endicott House in Dedham, and dinner in Sala de Puerto Rico followed by an excellent Pops concert. Friday included an educational meeting in Kresge Auditorium in which professors told us how computers will change our lives (if we are still around). The meeting was followed by lunch in the new Athletic Center and, in the early evening, a very interesting visit to the Isabella Stewart Gardiner Museum which included drinks and a buffet supper. Saturday we traveled by bus to Marblehead for a steamed clam and lobster luncheon at Eastern Yacht Club. The hours not accounted for above were spent talking with old friends, walking about the 'Stute or resting if need be.

The Reunion was continued on Sunday, Monday, and Tuesday at Wequassett Inn at Chatham on the Cape. Those present were the Appels, Kurtzes, Ellises, Merrills, Eackers, Zacks, Keanes, Marjorie Pierce, Bill Stose, Lachlan Mackenzie, Ab Johnson, daughter Joanne and granddaughters Elizabeth and Janet. A feature of the Wequassett phase was a party celebrating Ab Johnson's 83rd birthday on June 15. The success of the reunion was due to the untiring efforts of Class President Parke Appel, ably assited by Buck Eacker, plus the cooperation of the Institute in providing accommodations in McCormick Hall and arranging for lunch at Endicott House.

Our Class President, **Parke Appel**, suffered two strokes during February. Prompt help from his doctor and the hospital and the introduction of a pacemaker (plus the addition of a mustache and Talbot beard) have restored him to full command. . . . **Frank Kurtz**'s granddaughter graduated in June from Annapolis, all A's. The source of the nautical genes has not as yet been determined. Frank's skill at bridge results in a steady flow of students to his classes. . . . **Ted Miller** is running a successful business, The Plantarium, supplying flowers year round to about 40 retail florists. . . . **Sam Reynolds**' house in Tiburon, Calif., across the bay from San Francisco, is on a pier at the water's edge. . . . **Whit Ferguson** suffered partial paralysis from a fall in May. We hope by the time these notes are in print that he will be well recovered. . . . **Ab Johnson**'s granddaughter, Elizabeth Douglass, is so proficient at volleyball that

The Class of 1922 pose for their 60th Reunion picture during their visit to the Isabella Stewart Gardner Museum. (Photo: Scott Globus, '84)

she has received a full athletic scholarship at Northwestern. . . . Parke Appel had a letter from **Bert Weber**, our still functioning Chicago architect. Bert has found time over the years to make many major and minor trips in the U.S. and abroad for hunting, fishing and golf.

Chuck Brokaw's widow, Lorna, sends regrets that with the passing of Chuck in 1980 from terminal cancer, she could not be on hand at our 60th. . . . **Horace McCurdy** attended the graduation of his grandson from the Institute but circumstances precluded his staying over for reunion. . . . **Marjorie Pierce**'s efforts on behalf of the Women's Independent Living Group, the residence at 355 Massachusetts Avenue, have been recognized by renaming the building the "Marjorie Pierce House." A formal dedication will take place this fall. . . . **Ray Burrus** (who was at reunion) is the whistle blower in Hallandale, Fla. Ray, for the last 12 years, has written his opinion (unpaid) on current Hallandale issues in the weekly, *The Hallandale Digest*. Ray, not subject to anyone and with a tremendous following, is often at odds with the elected officials. An article in the May 17, 1982, issue of *The Miami Herald* tells the whole story. Quoting from the article, "One city official said, 'A lot of people don't agree with what he writes, but he's been around so long you can't help but like the crusty old guy.' " . . . President Appel received notes regretting inability to attend our reunion from **Crawford Greenewalt**, **James Spratley**, **LaMonte Griswold** and **William W.K. Freeman**.

We regret to inform you of the passing of many class members during these last months: **Allan S. King**, Minneapolis, Minn., February 21, 1979; **Francis M. Mason, Jr.**, Evanston, Ill., March 14, 1976; **Col. Elroy S.J. Irvine**, Washington, D.C., April 29, 1980; **William G. Rapp**, Larchmont, N.Y., January 10, 1982; **Alfred Wolf**, Berkeley, Calif., September 1, 1981; **Theodore Riegel**, Delray Beach, Florida, April 19, 1982; **Fay H. Osborne**, Sunapee, N.H., February, 1982; **Karl A. Swett**, Lakehurst, N.J., January 9, 1982; **Eleanor Spillsbury**, Woburn, Mass., April 9, 1982. The sympathy of our class goes to their families.—**Yardley Chittick**, Secretary pro tem, P.O. Box 390, Ossipee, NH 03864

23 60th Reunion

At the suggestion of Phyllis (Mrs. **Arthur W.**) **Davenport**, a copy of the article about Whitaker College (May/June issue of the *Review*) has been deposited with the record copy of our GREAT HISTORY in the Museum and Historical Collections. On April 5 your Secretary-Treasurer represented the Class at a "Joint 1983 Reunion-Technology Day Meeting" at which representatives from the Alumni Office presented much interesting information and distributed helpful literature for classes planning reunions. Copies of the literature were passed on to **Royal Sterling**. . . . Virginia (Mrs. **Herman A.**) **Bruson**, **Pete Pennypacker**, Mary and **Royal Sterling**, Kay and **Julius Stratton**, and your Secretary-Treasurer were at the 1923 table for the Technology Day luncheon on June 11.

Pete Pennypacker has learned that a new record of Technology songs has been completed and is ready for distribution. On one side are a number of old songs, and on the other side is a collection of new ones, including "To M.I.T." written by Pete for our class to sing at our 50th reunion. It was sung at our 55th reunion also, and was published in *Technology Review* a few years ago. . . . **Luis Ruiz de Luxuriaga** reports that his only son, Eusebio, is M.I.T. class of 1952. His granddaughter, Katharyn-Felina, is M.I.T. B.S. 1978 and M.S. 1980, and on June 19, 1982, was married in the M.I.T. chapel to her classmate Lloyd Maurice Alderson. He would like to hear from any classmates who can match or exceed his three-generation record. . . . **Al Pyle** writes that last April he snorkeled in Hanauma Bay amidst gorgeous tropical fish and from there flew with his sister to Kauai to visit friends. He also writes that he met President Paul Gray and his wife Priscilla in New York, and that he plans to attend the 100th anniversary of Course VI. . . . **William Upham** reports that after graduating from Course XV-2 he moved to St. Petersburg where he has engaged in the real estate brokerage, insurance, and development business until retirement three years ago. He is a past president of the St. Petersburg Board of Realtors, Charter Member and past president of Gulf Beach Rotary Club, and a member of the Board of Trustees of Eckerd College since it began 21 years ago. He is active in the Presbyterian Chruch.

Powell Robinson died on November 28, 1981. After receiving an A.B. degree at Harvard College, Powell graduated with our class in electrical engineering. His business career was in public utility management and investment banking. He was a member of the Harvard Club of New York City, and of the Morristown (N.J.) Club. He was a Trustee, Board of Managers of Morristown Neighborhood House, Mount Kemble Home, and Civil Defense Director, Morris Township. During World War I, he served in the American Field Service to the French Army. He enjoyed travel, tennis, small-boat sailing and orchid cultivation.

Tom Green '26, has sent a clipping from the *Hartford Courant* reporting the death of **George Will** on June 25, 1982. He attended Princeton for two years prior to graduating with our class in chemical engineering. He was variously employed by National Sugar Co., Long Island City, the U.S. Customs Office in New York City, Fidelity and Deposit Co. of Baltimore, and finally by Combustion Engineering, from which he retired in 1964 after an association of 33 years. He then formed Novatech Associates, an investment advisory service for institutions, in Avon, Conn. He was a member of the Avon Congregational Church and served on the Board of Trustees, a member of the Avon Library Board, former member of the Forest Lake Club, Hawley, Penn., where he served as treasurer, former president of the Briarcliff Swimming Club, Avon, and a member of the Hartford Ostomy Association.—**Richard H. Frazier**, Secretary-Treasurer, 7 Summit Avenue, Winchester, MA 01890

24

You all may have been satiated with class notes after the last *Review*, but news continues to arrive. Don Severance '38, now M.I.T. Director of Leadership Gifts, advises me that David Kane, grandson of **Chick Kane**, graduated with the class of 1982. Not only that, but David and the Institute expect to be the proud possessors of a patent as the result of his thesis. Don presented David with a complete, prized, personal set of M.I.T. steins designed by Chick over the years, to keep in the family. . . . A pleasant note from Helen and **Dick Shea** indicates that they are happily enjoying cool weather in South Yarmouth on the Cape, having left Venice, Fla., during the summer. They are planning on our 1984 Reunion at Endicott House, owned by M.I.T., in Dedham, Mass.

Harry C. Bailey died January 20, 1982, in Beaumont, Tex. He was awarded an S.B. in chemical engineering and immediately joined E.I. duPont de Nemours Co. in New Jersey. He was production supervisor for ten years, then assistant plant manager at the Baton Rouge, La., plant until April 1942, when he commanded the 161st A.A.A. Gun Batallion in Australia, New Guinea, Luzon and Japan. He returned to inactive status, O.R.C., Colonel. We have no further information except that he retired in 1967, living in Beaumont, Tex. Cliff was active in a number of Clubs at the Institute, serving as an officer in several.

Retired Naval Captain **Robert W. Hart** passed away on April 17, 1982, in Danvers, Mass., after a

Class of 1927 members (left to right) Ray Hibbert, Larry Coffin, Bud Fisher, and Dick Turner open their 55th Reunion at the M.I.T. Museum. (Photo: John Mattill)

Engineer Turned Ornithologist

The name of **Richard H. Pough, '26**, is "a synonym for conservation," says Russell W. Peterson, president of the National Audubon Society—"a name linked with almost every significant conservation issue . . . of the past century."

Moments later, Mr. Peterson—he was speaking at the annual dinner of the National Audubon Society on November 5 in New York—gave Mr. Pough the 1981 Audubon Medal, the society's highest award for distinguished service in the cause of conservation "in recognition of creative efforts in helping save the best, and often the last, natural and open spaces in this increasingly urbanized land."

In brief response, Mr. Pough—he was introduced as "an engineer turned ornithologist"—called attention to threatened "loss of genetic and species diversity" as "the folly our descendants are least likely to forgive.

"Species extinction is now accelerating and will reach ruinous proportions during the next 20 years," Mr. Pough said. A current estimate is the loss of 1,000 species a year, he said—most due to the destruction of tropical forests, a rate "vastly higher" than that of evolution of new species.

To control the threat, Mr. Pough proposed the need for a "more powerful global conservation ethic. . . . The endemic plants and animals of each nation should be regarded by its citizens as part of their heritage, as precious as their art and history." Because most of today's destruction is taking place there, and because of the great diversity of tropical life, "the challenge that lies ahead is . . . in the tropics of the world."

brief illness. He earned his S.B. in electrical engineering. He changed jobs about every five years "for variety of experience," then spent twelve years with the Submarine Signal Co., Boston. He helped develop a new radar system and acquired many patents for innovative electronic and mechanical devices. Five years of active duty in the U.S. Navy followed. He was the first person in New England licensed as a ham radio operator. After the war he served as a contract officer in the U.S. Navy's research office in Boston, retiring in 1964.

Another retired Navy man, Vice Admiral **Ralph E. McShane** passed away on May 3, 1982, in Point Pleasant, N.J., following a heart attack. After graduating from Annapolis, he received his S.M. degree in naval construction and engineering. During World War II he served in Europe and in 1945 became comptroller in the Navy Bureau of Ships. After a tour as commander of the Navy shipyard in Portsmouth, N.H., he returned to the Navy Bureau of Ships in Washington, D.C., retiring in 1954. In 1967 he moved to Brick Town, N.J. His military decorations included the Legion of Merit and the French Croix de Guerre.

A brief note from **Franklin O. Billings** in the northeast corner of Washington states: "Elected as commissioner of newly organized Port of Pend Oreille in 1978. Term expired December 31, 1981. Chairman of Port in 1981." Apparently the Pend Oreille river flows into the Columbia. . . . The Class was represented at the June 11 Technology Day luncheon by honorary member **Irwin Sizer, Don Moore, Don Fife, Del Kendall, Stuart Morgan, Herb Stewart,** and **Russ Ambach**. . . . After some searching, **Don Fife** will take on the duties of Deputy 60th Class Reunion Chairman to **Don Moore**. We are glad to have Don Fife working with us. He lives within traveling distance from Boston: Lawton Road, RR1, Box 206, Eastham, MA 02642, telephone (617) 255-0072. Although the Big Bash of '84 is two years away, your officers would like to know who is planning to attend, overcoming ski accidents, overimbibing and arthritis.—Co-Secretaries: **Russell W. Ambach**, 216 St. Paul St., Brookline, MA 02146; **Herbert R. Stewart**, 8 Pilgrim Rd., Waban, MA 02168

25

The activities of Technology Day 1982 were well attended by classmates. Present at the annual luncheon were **Will Gardiner, Jim Howard**, Adele and **Ed Kussmaul, Ed McLaughlin, Frank Mulcahy**, and yours truly. Joe Martori, associate secretary of the Alumni Association, a busy man on that occasion, did find time to join us at lunch. The list of registrants included **Sam Spiker**'s name but I did not see him. On June 12 Evelyn and I were among the guests of the 50-year class at their banquet. Those of us who were on the teaching staff while the class of 1932 was at the Institute were invited to this dinner. It was a pleasant occasion, and four of my former students of Course III were present.

Harry E. Thomas writes a note saying he just had his 80th birthday and still enjoys tennis. He retired from IT&T in 1964 and since then has had ten technical volumes published by Prentice-Hall. He retired to Columbia, S.C. in 1974.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26

Mid-July in Boston has brought us the usual heat wave with temperatures in the nineties and a deadline for the October issue of the *Review* with sparse news of our classmates. Just a week ago we ran across **Joe Levis** and **Abe White** with their spouses at a high school reunion. The Whites were enjoying retirement and continue their active interest in M.I.T. affairs including the periodic luncheons at Endicott House. Joe and Yvonne continue their devotion to modern dance, spending four or five evenings a week enjoying it, even to the neglect of golf (which I used to play with them on occasion). In a later chat with **Bob Dawes** he mentioned that his former roommate, **Stark Draper**, has for years, in addition to his multitudinous other activities, been a modern dance enthusiast. Bob also mentioned that the decorative shoelaces which he presented at our 55th have enjoyed a tremendous vogue, including his company's appointment as supplier to the Olympic Committee for the next twelve years. Bob is still actively involved in his company's affairs (his daughter is president) and the business is flourishing, as are he and Evelyn. We talked of our coming mini-reunion at Endicott House in June 1983, and our hopes that some of our classmates and wives whom we have not seen for some years would be with us at that time. Perhaps **Bud Wilber**, now living in Hancock, N.H., will join us in singing the official M.I.T. song, "Sons of M.I.T.," which he composed.

A note from **Bob Ellis**: "Still in harness and working full time. We are fortunate, my wife and I, to travel to Europe twice a year." . . . **Bob Dean** has been named chairman of the board and senior vice-president of Perry, Dean, Stahl and Rogers, Inc., Architects, Boston, Mass. . . . We have just received delayed notice of the death on January 20, 1981, of **Sydney E. Miller**, with no notice of survivors.—**William Meehan**, Secretary, 191 Dorset Rd., Waban, MA 02168

27

The best accounts of reunions are the attendees' impressions. **Elwood Chruch** sent this message: "Elinor had not been to any of our previous reunions and had no means to compare this one but wants to say that our reunion was the most enjoyable vacation she has had. What impressed her most was the friendliness between everybody, both men and women. I, too, feel it was the most enjoyable, tempered somewhat by the absence of several good

Walter J. Smith, '28, (left) and James Donovan, '28, help Richard A. Knight, '47, into a red blazer. The jacket commemorates Mr. Knight's new honorary membership in the Class of 1928. He is the retiring secretary of the Alumni Association. William J. Hecht, executive vice-president of the Alumni Association, narrates the surprise from the microphone. (Photo: Scott Globus, '84)

friends who have passed on. The pre-Pops dinner and Pops concert were superb, both musically and socially. The only suggestion I have if we go to the Cape again is to avoid that traffic jam on Friday afternoon." . . . **Larry Grew**, who has agreed to help on the secretary's notes, writes: "Compliments to the committee and the program—fine arrangements, well organized, very friendly. Museum, cocktails, and dinner excellent. Pops dinner and concert excellent. Technology Day luncheon had its problems and got us off to a difficult traffic situation on the way to Wianno. We liked going to the Cape after Cambridge."

John Crawford writes: "Lane and I thoroughly enjoyed ourselves at Cambridge and Wianno. Because we got delayed at several points in the program, we had a good chance to see how the arrangements stood up under maximum stress. The Alumni Association did very well. The shuttle bus service they provided was a godsend. I am slightly disabled and get around very well with a cane just so long as I can stop to sit down frequently. Our thanks to the 1927 reunion committee and the Alumni Association. Also thanks to the students who helped at Burton House." John and Lane live in Great Neck, Long Island, where he moved after Pearl Harbor to work at Hazeltine Electronic Corp. as senior engineer. He retired ten years ago and manages to keep active. Their son and family also live on Long Island. . . . **Harold Heins**' wife, Esther, took a lot of candid pictures. She is very talented. Some of her colored drawings of plants are being printed in this year's issues of *Horticulture*. . . . **Bud Cole** kindly offered to assist on class notes. We are very appreciative and look forward to news from California. . . . The croquet match was well coached by Jean (Mrs. **Dwight "Dike") Arnold**. She is a recognized English croquet contender, and we are very pleased that she attended.

Tom Knowles was appointed nominating committee chairman and after much deliberation, arm twisting, and handshaking, the following officers were elected: **Bud Fisher**, president; **Ray Hibbert**, vice-president and reunion chairman; **Dick Hawkins**, vice-president and class agent; **Russ Westerhoff**, vice-president and estate secretary; **Joe Burley**, secretary; **Larry Grew** and **Bud Cole**, assistant secretaries.

We are sorry that circumstances and health reasons prevented many who planned to attend from coming. Notes of disappointment with best wishes for the reunion were received from: **Ned Anderson**, Westwood; **Luke Bannon**, Sanford, Fla.; **Al Billings**, Richmond, Va.; **George Brady**, Washington, D.C.; **Stuart Bugbee**, Wilmington; **Gordon Calderwood**, Rochester; **Fordyce Coburn**, Pueblo, Colo.; **Bud Cole**, Palo Alto, Calif.; **Nat Cohn**, Jenkintown, Pa.; **George Darling**, New Haven; **Carl Davies**, Charleston; **Bud Gillies**, Rancho Santa Fe, Calif.; **George Fexy**, Kirkland, Wash.; **Charles Kingsley**, Lexington; **David Knox**, Lantana, Fla.; **Wes Meytrott**, Brooklyn; **Roger Knowland**, East Blue Hill, Me., **Ted Ordman**, Stanfordville, N.Y.; **Paul Parker**, Fair Oaks, Calif.; **Anson Rosenthal**, New York City; **Ken Smith**, Calais, Vt.; **Frank Staples**, Floral Park, N.Y.; **Charles Sweet**, Milford, N.J.; **Bob Wallace**, St. Charles, Ill.; **Leslie Weed**, Wellesley; **Joe Yates**, Wyandotte, Mich.

What an indication of the class spirit in these letters from all these fellows around the country! It takes a reunion to discover this. As we get older we recognize the ties we have in starting off together in 1927. Let's try to foster this by arranging area mini-reunions.—**Joseph C. Burley**, Secretary, 5 Hutchinson St., Milton, MA 02186; **Laurence B. Grew**, Associate Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole**, Associate Secretary, 2150 Webster St., Palo Alto, CA 94301

28 55th Reunion

Rest assured, good fiends, '28 is definitely upholding its reputation as a class of great enthusiasm and spirit! It is mid-July as these notes are being written and results of our initial postal survey are in. This survey, as you will recall, was to determine the level of interest in our 55th Class Reunion to be held in June. With a current active class membership of about 365, there were 124 responses comprising 85 "yes" returns (planning to attend) and 39 "regrets." Counting spouses and guests, the total "planning to attend" stands at 147. This is much more than a remarkable indication. We have the promise of a wonderful party - don't miss it!

Brief notes came with some of the cards and we are happy to share them with you: **Gene Boehne** has had two recent trips to the hospital (Lahey Clinic). In mid-June he spent a day with **Orin McCarthy** and family. . . . On May 16, 1981, the Oklahoma Medical Research Foundation announced the establishment of the **Tom Garrard** Distinguished Scientist Lectureship. Linus Pauling was the first lecturer in the spring of 1982. Then, on January 7, 1982, Tom was elected an active member of the New York Academy of Sciences. . . . **Tom Harvey** reports that he had open heart surgery in January then had his third trip on the Delta Queen in May. . . . **John Houpis** says he will be traveling 5000 miles to be at the 55th but complains only that time is so short. . . . **Morey Kliegerman** was elected director emeritus at Camp, Dresser and McKee after serving as director for ten years. . . . **Henry LaCroix** was at the Lahey Clinic for several days in April with a headache problem; he still has the problem. . . . **Jim McCarthy** is still doing some consulting, playing golf and teaching a class in water color painting. . . . **Walter (Norkevicious) Norton** reports that, thanks to medical technology, he has now joined the "pacemaker" class. . . . **Don Perry** is keeping busy and active; he and Vera are vacationing in New England this year. . . . Claire and **Ted Pierce** were on the West Coast last year for Claire's 50th Reunion. They used the opportunity to chat with Velma and **Charlie Worthen**. . . . **Bob Proctor** has a new address (available on request). He is busy with a "barbershop" singing group, a retired men's club, Kiwanis and "babysitting" with a 90 year old mother-in-law. . . . **Joe Riley** says they had a good winter in Florida and are looking forward to seeing everybody at Cambridge in 1983. . . . Novice and **"Tex" Sandidge** tell us that '28 was the oldest class at a recent Austin, Texas M.I.T. Dinner. . . . From **Leonardo Siller** in Mexico we have his expressed wish for a 55th Reunion comparable to the 50th. . . . Jo (Mrs. **Ed**) **Shiepe** is planning to come and looking forward to it all. . . . **Ed Ure** was married December 28, 1980, to Ruth Stansfield who is now eager to be at her first M.I.T. reunion. . . . Peg and **Ted Wood** have just returned from a two week cruise that took them through the Panama Canal. Now they are about to visit their son in Maine. We have a number of other notes and letters to report in the next issue.

With deep regret we must record the deaths of five classmates. **D. Yancey Bradshaw** died unexpectedly on October 26, 1980. His daughter, Carol, thoughtfully wrote to inform us. Brad graduated in Course VI-A, electrical engineering. His professional career was in the visual entertainment field—motion pictures and TV. Wife Clara died some time earlier. . . . **Otto Brune** died April 27, 1982, after several unwell years. This information was provided by his wife, Grace, writing from their home in Pretoria, South Africa. Otto leaves also a daughter and four grandsons. . . . **Cal W. Caldwell** died April 13, 1982, after an extended illness. Cal graduated in Course XV, business and engineering administration. In a note to us, wife Kathryn says that Cal was circulation manager for Sears Catalogue Department for 35 years. Also that he was very active in civic affairs in his town of Lombard, Ill., where he had lived for 46 years. Cal leaves two sons and a daughter. . . . **Elston W. Meyer** died April 18, 1982. Elston studied in Course II, mechanical engineering, but we have very little information relative to his career. His wife survives. . . . **Theodore Packard** died February 25, 1982. Ted graduated in Course III, mining engineering. His professional work was in metallurgy, engineering and administration, mostly with Driver-Harris Co., Harrison, N.J. A note from his wife reminds us that Ted was instrumental in organizing the first orchestra at M.I.T. which, up to that time, had been the Mandolin Club. . . . To the families of these classmates we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890

29

Technology Day 1982 was attended by the following '29ers: **Arthur Bearse**, **"Put" Cilley**, **Gordon Williams** and wife Olive, and your secretary and his wife Helen. On the same day, **Jerry Gardner**, general chairman of our 55th Reunion, had a luncheon meeting scheduled at the Faculty Club which was attended by (alphabetically): **Bill Baumrucker** and wife Doris, President **Bill Bowie** and wife Sally, **Paul Donahue** and wife Fran, **Ruth Fahey**, **Wally Gale**, Chairman **Jerry Gardner** and wife Mary, Professor **"Fritz" Meissner** and wife Dorothy, **Joe Speyer** and

Russ Robinson, '32, is at the keyboard. A 50th Reunion is a time for informal entertainment and socializing as well as ceremony. Photo: (Scott Globus, '84)

Dave Wilson. Prior to the meeting, Wally had sent a letter to Jerry proposing a number of alternative places and dates for the committee to consider. It was decided to have a letter drafted, incorporating some of the suggestions put forth by Wally and sent to the members of the Class of 1929 to obtain a consensus and some output as to what the majority wishes to do. By the time these notes get into print, you will have received the letter from Jerry. Since the reunion is less than two years hence, I urge you to reply promptly, if you haven't done so already.

During the past year, **Charles Frank, Jr,** of Waltham, Mass. has been very active attending weekly meetings of the Kiwanis Club of Waltham. He also sings with the Highland Glee Club of Newton, having participated in seven concerts in May. He attends bi-weekly meetings of the Retired Men's Club of Newton. . . . **J. Wesley Walters** of St. Paul, Minn., writes, "We celebrated our 53rd wedding anniversary of June 27th in Lincoln, Nebr., with our daughter whose birthday is on the same date. We still enjoy travelling and have planned more trips for the near future. Thanks for the birthday card—'Salutation to Dawn' is greatly appreciated."

J. Henry Giles of Altadena, Calif., writes that he has been retired three times from various activities and jobs. He has married and lost two wives by death and recently married his housekeeper in the retirement home. The guest house has nine bedrooms and seven fireplaces. The home is situated on an acre of land with fruit trees, flowers and bushes, which keeps him busy. He has a son and a daughter and six grandchildren. He is sending his greetings and best wishes to all his classmates, especially to "Put" Cilley, and Art Bearse.

Russ Clark of Dallas, Tex., has finally retired from Vought Co. and his aerospace consulting business. He says, "I had too many things, between home projects and condominium investments in Colorado (Rockies) and New Mexico. Dot and I recently have been interested in antique furniture and restoration of some from New England estates, of our parents. We keep up with events of M.I.T. through the Sustaining Fellows Programs. We are glad to see that the plans are underway for the 55th Reunion which we plan to attend and hope that it will be as enjoyable as our 50th. Greetings and best wishes to all our classmates."

Miriam, wife of **Clayton F. Jarvis** of Amesbury, Mass., writes that Clayton is now legally blind which puts a damper on many things. "We still go to Sarasota, Fla., in the winter and the weather was one of the best and warmest in 23 years this past season. One new development in our lives is that our daughter has now moved to Amesbury, near us, from Baton Rouge, La. She is a department manager at Filene's in the Northshore Shopping Center. She is a big help and full of pep, which lights up our hearts" . . . **Edwin H. Perkins** of Georgetown, Mass. writes, "I am now doing and enjoying all the things that I did not have time or the money to do while working. I have a 26-foot sailboat and cruise in between Maine and Connecticut. I am still active in the United States Power Squadron at national, district and squadron levels. I am also the treasurer of our local Eastern Star and Rainbow Girl Chapters, and active in our Masonic Lodge."

Helen May Walthers of Blairstown, N.J., writes, "I still live on our 240 wild and lovely acres in northeastern part of N.J. I live alone, but the place is always full of friends, including my children and grandchildren. The days fly by, full and joyful and I am never bored or lonely. My interests include gardening and political and environmental activities."

Jonathan F. McCray of Heber Spring, Ark., writes, "I appreciate greatly your personal notes. I am so glad to hear that Teddy Fahey had adjusted so well to Jim's death. I am at present so overloaded with work that I plan to resign from the State Board of the American Cancer Society this fall as my political chores are going to keep me busy until after the November elections. Isabel and I had planned to take a trip to south Texas last Christmas. At the last moment, Isabel asked if I was going to be disappointed if we didn't go. Thinking it over, we both concluded that we would be more comfortable at home than taking the trip. Is that a sign of getting old? I saw Arch Copeland '38, recently. He and his wife Jo Anner had just returned from a trip to south Texas and stayed in a place in Laredo called "La Posada," where we had stayed a few years back. It is a delightful hotel. Arch works with me on the Tax-Aide program for the elderly during the tax season. Both Arch and I enjoy doing this volunteer work. Best wishes to all."

Charles L. Huston, Jr. of Villanova, Penn., has sent a note stating that he has retired as chairman and chief executive officer of Lukens Steel Co. of Coatsville, Penn., as of 1974. He and his wife Nancy spend the winter months in Delray Beach, Fla., and summers on Nantucket Island in Mass. In between, they are at home or travelling. His hobbies include golf, tennis and boating. They have three children and 12 grandchildren . . . **William E. Lowery** of Plymouth, Mass., is currently involved in the re-election campaign of State Senator Ned Kirby and State Representative Peter Forman. He is also supporting Roy Shamie in his run for U.S. Senator from Massachusetts against the incumbent Ted Kennedy. He is still active in town government, while his wife Charlotte does volunteer work on the Red Cross bloodmobile and other community activities. His hobbies include electronic experiments and reading detective stories. They have two children and five grandchildren.

Adrian (Cub) Clark of Woodbury, Conn., states that he is more active than ever reading with LD's in Bethlehem Elementary School, singing with the Connecticut Choral Society and trying to get his golf handicap down.—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

30

Supplementing the item about **Byron Mackusick**'s death in the May/June issue, **Les Steffens** has provided me with a rather intriguing reminiscence. During the thirties Byron was working for Socony-Vacuum (now Mobil) and Les worked for Pure Oil just across the Delaware River from Byron; they often saw each other at AIChE meetings. When Byron moved from Socony to Pure Oil, Les decided to apply for the job Byron vacated. It turned out that Byron was one of a group of three employees that Pure Oil hired away from Socony. Hence Socony was quite delighted at the idea of hiring Les away from Pure Oil. . . . Marion and **Bill Dickerman** live in Manhattan but spend their summers in Nantucket where Bill says he "got roped into engineering the watering system on the golf course of our local club there." Bill reported that he and Marion were "doing very well" and were busily engaged in preparations for the Wellesley '82 granddaughter.

Win Hartford is continuing to write and speak on environmental matters and of late has been particularly concerned about acid rain. During the summer of '81 he spent 3 months in Leon, Mexico on an assignment straightening out production problems for a chemical plant. He was able to increase production by 28% with no increase in capital or labor costs. More recently he had a bit of a set back when he fell backstage during a rehearsal and injured his leg. He says that "the injury, a rare one, consisted of my pulling my quadriceps tendon clean off the kneecap. I'm told it's usually seen on high school basketball players, which is small comfort."

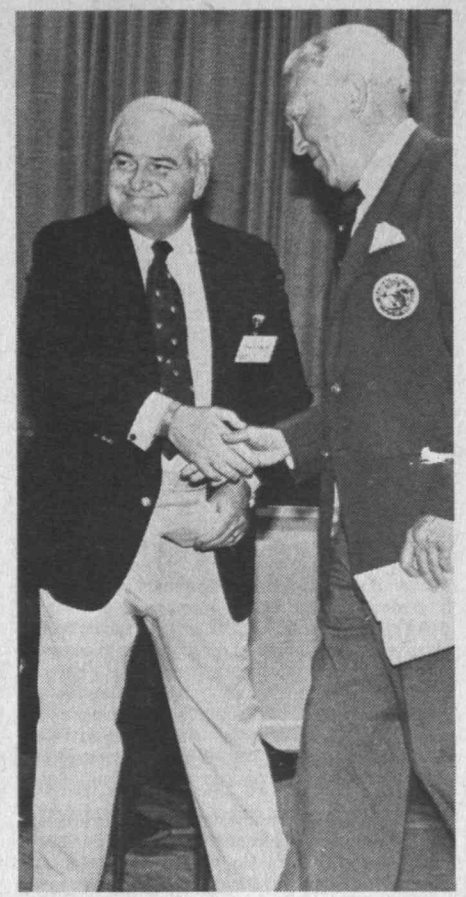
Bob Rypinski reports that he is more retired than ever since Armor All Products, of which he was a director, was sold in 1979. For the past year or so he has spent a lot of time on calculators such as HP 41, TI 59 and Radio Shack's TRS minicomputer.

We have at hand recent reports from two classmates who live in British Columbia. **Doug MacDonald** writes from Nelson, B.C. that he and his wife spent the winter in Laguna Beach. During the summer they will drive east for a family reunion in New York State and then go on to England and the continent for an indefinite stay.

Joe Kania reports that he recently completed his 27th overseas trip as a representative of the Vancouver Board of Trade and has now visited a total of 55 countries. The most recent trip included stops in South Africa, Zimbabwe, Zambia and Kenya. He was particularly impressed by the Sasol Plant #1 in South Africa which is designed to convert 40,000 metric tons of coal into petroleum products and chemicals. It is anticipated that upon completion of two other units now under construction South Africa's need for imported oil will be eliminated. Joe recently celebrated his 81st birthday with a party at which he entertained the guests by showing them some of his 26,000 travel slides and then playing the violin for a "sing-song."

We have at hand notices concerning the deaths of two more of our clasámates: **Rael Morris** on August 28, 1981, and **Harry Beohner** on January 1, 1982. Unfortunately, I do not have any information about Rael Morris other than the fact that he lived in Coffeyville, Kans., at the time of his death. Harry

President Paul E. Gray receives $1,375,000 from 50th Reunion gift chairman Robert B. Semple, '32. The gift was 20 percent over the Class of 1932 goal, and 64 percent of the class participated in the effort. (Photo: Scott Globus, '84)



Beohner was a vice-president of Pfaudler-Permutit, Inc., in New York in the fifties. About 20 years ago he left Permutit to go into business for himself. His company was Wilner Engineering Co., of Stamford, Conn., which specialized in sales and service of domestic and commercial water conditioning equipment.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

31

Thanks to the Alumni Association, I received news that **A. Harry Wagner**, who retired in January 1974 from Southern Brick Contractors, Inc., in Richmond, is now executive secretary of the Virginia Concrete Masonry Association.

The same source has notified me of the death of **Roger R. Trengove** on February 16, 1982. Roger was born on August 2, 1906, in Prescott, Ariz., where his father was a mining engineer. He attended high school in Prescott and Berkeley, Calif., and graduated from the University of Arizona as a chemical engineer. This was followed by two years of graduate study at M.I.T. He met his wife, Dorothy, at a church function in Cambridge and made their first home in Ashland, Ky., where Roger was a chemical engineer for Ashland Oil Company. Four years later he moved to Ponca City, Okla., where he worked for the Continental Oil Co. for 35 years before retiring in 1968. After retirement, he and Dorothy traveled and camped some 350,000 miles throughout the U.S., Mexico, Canada and Europe. Our sincere condolences to his family.

Your Assistant Class Secretary, **John Swanton**, has written me concerning the Technology Day meeting early in June: "Louise and I came back from Maine for Technology Day at the Institute on June 11. As usual, perhaps even more than usual, it was an impressive gathering, with all the 'quin' classes making their Alumni Fund presentations, usually in record breaking amounts, as ours was last year (and sitll is thanks especially to **Ken Germeshausen**.) The technical emphasis this year was on computers, with an impressive panel of worldwide experts. At luncheon we had a chance to visit with classmates **Gordon Brown**, **Charlie Seaver** and **Shel Smith** and his wife Harriet. Gordon is in New Hampshire now; he rotates his residence as a number of us do. He winters in Tucson. (Louise and I are in Maine and Newton, Mass.; several others are in Massachusetts and Florida). **Charlie Seaver** remains active in solar projects. He's in Needham; Shel is in Falmouth, Mass. My assessment of our gathering was that there are four healthy looking classmates. Too bad more couldn't be present."—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John R. Swanton, Jr.**, Assistant Secretary, 27 George St., Newton, MA 02158 (after November); **Ben W. Steverman**, Assistant Secretary, 3 Pawtucket Rd., Plymouth, MA 02360

32

Our long heralded 50th Reunion finally arrived. This June 9th the sun burst through the clouds and remained with us through our long weekend. All of us were in a merry, social spirit. The program was a pleasant mixture of nearby luncheons and dinners. Our guests were Mrs. Howard Johnson, Dr. Harold Edgerton and his slides, and Dr. and Mrs. Stratton. Besides Tech Night at the Pops, there were other diversions such as a Beacon Hill House Tour, Technology day, a visit to the M.I.T. Museum, golf and tennis. Every night we gathered at McCormick Hall for more socializing and often singing around the piano. Old friendships were renewed and new friends made.

The Alumni Association lists our class as originally having 746 members. 281 have died and we have no addresses for 66 and therefore have lost contact with them. Of the 399 classmates with addresses, 92 were able to attend our 50th and about 65 who were unable to attend ordered our class book and résumés. Anyone wanting a list of reunion attendees and guests can receive a copy by writing to the *Review*.

Our memorabilia room attracted considerable attention. We had books written by **Elmer Stotz** and **Jacob Millman**, patents by **Robert Prescott**, and electrostatic artwork by **Al Dunning**. Many brought in pictures and newspaper clippings of our early school days. **Robert Semple** presented our class gift for $1,375,000 with an additional $800,000 of future interest. 67 percent of our class contributed to our gift.

There was a memorial service for M.I.T. Alumni at the M.I.T. chapel for those reported deceased from April 28, 1981 to April 16, 1982.

The 1932 classmates listed are as follows:

John G. Cree	**George F. Meyer**
C. Milton Daniell	**Frederic I. Miner**
G. Donald Freeman	**H. Kelsea Moore**
Richard R. Hall	**Louise S. Rousseau**
Robert H. Hubell, Jr.	**Gardiner A. Smith**
Edward R. Levine	**Farrow L. Tittle**
Frederick L. Mahoney	**Louis J. Vassalotti**
Earle M. McKellar	**Charles C. Wyatt**
Donald I. McSheehy	**John F. Yeager**

The new class officers for the next five years as reported by **John Brown**, chairman of the nominating committee, are as follows: President **Don Brookfield**, Vice-President **Wendell Bearce**, Treasurer **George Kerisher**, and Secretary **Melvin Castleman**. More later.—**Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swamscott, MA 01907

33 50th Reunion

Top item, this time around, is a Fund capsule from **Stan Walters**. This bit arrived a few hours after the previous notes were mailed. I quote, "Best news is that our classmate **John Sterner** has purchased a condominium in Quechee, Vt., as a vacation/retirement home. Quechee is just minutes west of White River Junction and minutes east of Woodstock. Dorothy and I had lunch with Delphine and John late last fall, and we hope to see them more frequently from now on." Now he tells me! Anyone traveling west on Route 4 into Vermont will recall the beautiful old gorge right under the road at Quechee. It appears that we can safely say, "Welcome to the Sterners on becoming New Englanders." . . . We have a fine letter and postcard from Charalee and **Dick Fossett**, both based on their trip to Iceland, but written when they got home as Dick did not have my address. P.O. Box, Exeter, N.H. reaches me easily (small town). Though the Fossetts are hikers, they found it convenient to rent a Scout four wheel drive in order to get into exploration. Please may I interrupt to say that I, too, have been to Iceland. With different objectives, Dick and I have seen most of Iceland. The northern half has the famous glaciers, including the biggest waterfall in Europe, Dettifoss. The eastern end of the island contains the famous hot springs, which furnish heat to the whole settled part of the country. One peek at the map makes one wonder at the total absence of artificial heat; no fuel is needed at all. The Fossetts then flew to Scotland where hiking is a national pastime. They climbed snow covered Ben Nevis, the highest peak in Britain at 4,400 feet. Many thanks, Dick and Charalee.

Bill Harper comes through with three letters in one month, covering many items not material for these notes, but useful. The new art studio for wife Bobbie is now in operation. However (this one should get you), her title is Yard Man, or better, Yard Boss. I have to take it that Bobbie must have traded the studio for manual labor outside, forsooth. Bill has the 50th in mind as he shakes up the plans. He did want to drive all the way. However, Bill suffers from hypoglycemia (low blood sugar) and driving is out of the question. They will fly to Cambridge instead, though plane service to and from Hattiesburg is rather poor. I recall driving New Orleans to Meridian via Hattiesburg during World War II; there was no plane service at all. . . . We have a Fund capsule from **Bob**

Wellwood of Charleston, W. Va. Bob's wife passed away last year so he lives alone, but with an interesting hobby. He is restoring two classic old automobiles that he has had over 40 years: a '29 Lincoln, and a '29 Minerva. Thanks for a fine note, Bob.

Last, but far from least, is a report on one of our better Technology Days. It used to be Alumni Day, and in fact still is. We had eight classmates and four wives, in both cases probably a record. To wit: Georgina and **Bill Barbour**, **Clarence Farr**, Rita and **Tom Galvin**, Alice and **Ferdy Johnson**, Anne and **Fred Murphy**, **Ed Simpson**, **Dick Valentine** plus Ye Secretary. We have one observation, probably a record. **Tom Galvin** has attended every possible Alumni Day since 1933. Those days that he missed were during World War II, when he was in the service of his country. There must be others, and I suggest that someone ought to look into the possibility of a record. . . . With no chance to pick up news on the big day, I wrote a card to each classmate asking for personals for these notes. I received one reply, that one from **Clarence Farr**. He says that he is very, very busy in his overactive retirement. He says that Bob Semple, who presented the Class of '32 contribution, was his predecessor as the leader of the Technotians. His choral group is quite active having, on average, about one concert every other month. He is the piano accompanist. He also dabs in ham radio, as a secret passion. He is also manager of the land division of a local real estate firm. He allows that class reunions are held as get-togethers to see who is coming apart. Many thanks, Clare. . . . We have an interesting comment to make re **Dick Valentine**. He and I went to Cleveland soon after graduation. He stayed only a short time because GM moved him to Hartford, Conn. As a result, 49 years elapsed with no contact whatever. Sure glad to see you, Dick, after all those years.

We have two of ours who have passed away since our last reporting. **Raymond J. Hoffman** of Belleview, Wash., architect. No details were available. **William P. DeCamp** of Randolph, N.H. passed away on April 20, 1982. Bill was a life member of the A.S.M.E. and was very active in civic affairs in his Randolph, N.H., home. He suggested that any of us who wish may contribute to the American Cancer Society, in his memory.

That's it for this time around. We wish you all well and we're looking forward to the class gift, to be presented on Technology Day, 1983.—**Warren J. Henderson**, Secretary, P.O. Drawer H, Exeter, NH 03833

35

Ed Taubman in his "letter of the decade" reports on the first of our mini-reunions: "This past Sunday, in order to drum up enthusiasm for the approaching 50th, Cele and I hosted a group of 1935 classmates from Maryland, D.C., and Northern Virginia. The event was a Sunday afternoon cook-out and mini-reunion. In attendance were the following classmates, some of whom were graduate students in our 1935 year: Betty and **Charley Perry**, Elsie and **Phil Wakeman**, Betty and **Malcolm Porter**, Marion and **Frank Walters**, **Lou Fong**, **Larry Stone**, **Lee Abramowitz** and **Molly Tatel**, and Carol Selison '71 represented the Alumni Association. **Darwin Stolzenbach**, **Dick Parli** and **Joe Fisher**, who had planned to attend with their wives, had to cancel at the last moment because of brand new grandchildren, etc. I think we all thoroughly enjoyed each other's company. And since most had never returned for a class reunion, I think they enjoyed themselves enough to give it serious consideration three years hence. The weather was a little hazy, but very hot and humid. The food was good (I cooked the hamburgers and burnt the hot dogs). Bloody Marys and cold beer were the favorites. However, we all gratefully adjourned to the air-conditioned interior to enjoy the watermelon and chew the fat. After a group picture, everyone departed as they had 40 to 75 miles to travel and our ancient bones needed pampering. I thoroughly recommend this mini-reunion to any group of five or more '35ers who live within 50 miles of each other. The only drawback is that the host is so busy hosting, he doesn't have as much time to enjoy 'chewing the fat' as do the guests. But there was a shared warmth just by being with my teen-age peers that I do not find in my usual social peregrinations. The only other news is that I disposed of my boat in 1981. Cele said it was either 'her' or 'it.' After three weeks of soul-searching, I sold the boat. I'm still troubled as to whether I made the right decision." Ed also said, "I am in generally good health except for an occasional kidney stone, too much blubber, and too much smoking. I am still managing real estate with my brother. I arrive at office by 11:30 and depart by 4:30, reading the *Wall Street Journal* mostly in between." Thanks for your letter Ed, I'll be ready for your next letter in 1992!

Ned Collins and **Randy Antonsen** are planning a mini-reunion for those around New England this fall. It will be a luncheon at M.I.T. or possibly Endicott House in Dedham. Rhoda and **Bernie Nelson** will have one for classmates and wives on the Cape later this summer. **Goffe Benson** reports he is getting one under way in Connecticut and upstate New York. **Phil Johnston** says that he'll be doing something in his area. . . . Bernie is looking for more and more reports. Any thought you have about what we should do for our 50th will be appreciated. Send your ideas to Bernie or to me.

Les Brooks wrote from Rockmart, Ga., "I was beginning to think that I'd have to default this first round (in the 22nd Class Golf). Players in my age group don't seem to have the stamina for more than nine holes. Besides, less and less people seem to be playing because of the economy. I had firm dates with the manager of the local Coca-Cola plant for three days this past week but auditors, six-month inventory etc., etc., wouldn't let him get away. So I was pleased when **Jim Moore** showed up today. He's a Bendix vice-president retiree also from up North so we have lots in common. Back in May, Ellen and I accepted a longstanding invitation to join old Connecticut friends in Hilton Head, S.C. We played the Sea Pines Club, Harbourtown and the Sea Pines Ocean Course. I had 109, 103, and 102. The courses are absolutely beautiful but you get the shakes looking at the narrow fairways and water and sand everywhere. One day my ball stopped 20 feet from an alligator that was sunning himself a few feet from his favorite lagoon. He was good sized and I was glad to leave him behind. I wrote **Dick Bailey** a couple of months ago as I thought I might get up there about now to play our first match and then stop at Knoxville for a day or so. However, the heavy rains all spring forced me to change my plans. My bottom land was still too wet. But a week ago I took a crack at plowing and discing with some success. Since then I have been frantically planting but have a long way to go. I was down there ten hours today and going down again in a few minutes to pick more peas. I made a second and third planting on March 1st and 15th and they are almost all coming in at the same time. Blackberries will be coming in soon but we've still got many jars of jam left from last year. Ellen keeps finding containers of frozen berries at the bottom of the freezer so desserts for the next month will be blackberry cobbler followed by strawberry shortcake. As you might guess, we're pretty content and active but Ellen has slowed down a bit with arthritis so we won't be dancing at our 50th, but might try." After that, I'm in favor of having a blackberry/strawberry festival mini-reunion in Rockmart. How about you?

Robert G. Clarke's note came to me through the Alumni Office: "Enjoying retirement in Winter Haven, Fla." . . . **George C. Morrissette** also sent a note: "Retired from General Electric in 1979. Living in Louisville, Ky., with my wife Dorothy. We both went to Rogers High School in Newport, R.I., and have been married for more than 45 years. We have two sons and two grandchildren." . . . Our older daughter Pamela Trombino presented Doreen and me with an adorable second granddaughter, on July 10th, named Leanna Marie. A third grandchild is due about July 20th from Kay and Chris Mowatt living in Newburyport. Their first will be three years old in September. On August 28th, our younger daughter Melissa marries John Szczepanski and will live in Waltham. John works at Draper Lab and Melissa at M.I.T. Greetings!—**Allan Q. Mowatt**, Secretary, P.O. Box 92, Newton, MA 02195

36

Some '36 "Eager Beavers" have decided that there should be an opportunity at our mini-reunion for sharing some of our expertise with discussion on some specific topics, including news from your Secretary, "something technical" from **Walt MacAdam**, and comments on investments from one of our more knowledgeable members. So here it is!

'36 MINI-REUNION
Saturday, 30 October, from 11 a.m. on.
Place: Home of **Alice Kimball**
28 Hartland Pond
West Hartland, Conn.
What: Lunch and Supper, Elbow Bending,
Hiking, Boating, and, after lunch,
discussions as described above.

If you would like to be included let **Eli Grossman** (2 Candlewood Lane, Farmington, CT 06032) know. His telephone is (203) 673-0936.

Technology Day activities brought a goodly turnout, some just for Pops, but more than a table full for the luncheon. We were saddened to learn from Florence Cooperstein who attended with two of her sons that **Ben Cooperstein** had died unexpectedly in early June. Around the lunch tables were: the **Ken Arnolds**, **Herb Borden**, Vivienne and **Eli Grossman**, **Leo Kramer**, Lillian and **Larry Peterson**, **John Zeitlow**, and your Secretary. Clayton and **Elliot Robinson** attended the program and were last seen busily examining the computers on display. The Pops list also included Rose and **Ed Dashevsky**, Natalie and **Lewis Gilbert** and **Herb Metten**.

Dorian Shainin is in the news again—this time as the recipient of the American Society for Quality Control's Eugene L. Grant Award for demonstrated outstanding leadership in the development and presentation of a meritorious educational program in quality control. Dorian started with what is now United Technologies and in 1952 joined Rath and Strong, Inc., management consultants. He continues in great demand as a speaker and consultant. What stamina!!!

Elliot Cullaty notes that for thirty years he has been president of J.F. Bingham Manufacturing Co., precision sheet metal fabricators in the electronic field. . . . **Larry Peterson** has been clearing out and has sent me some fascinating material which I will keep for future gatherings. . . . Furthermore, I can personally attest that **Gerard Chapman** and **Hib Summersgill** ushered at Tanglewood again this past summer. It's a fine way to hear the concerts, often from very good seats. . . . In closing I want you to know that all present who knew Ben expressed sympathy to Florence Cooperstein. If any of you want to reach her the address is 40 Windfall Road, Belmont, MA 02178. . . . Just in case you find at the last minute that you can join us on the 30th of October my telephone number is (203) 379-3807.—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, CT 06091

37

I am writing these class notes in the last week of June after a memorable 45th Reunion. Fifty classmates joined us at Martha's Vineyard. A complete list is available from *Technology Review* for those who may want it.

At the class meeting your class officers were reelected except for treasurer **Joe Heal**, who asked not to have his name placed on the slate because he felt someone living closer to the class officers in the Boston area would be preferable. Accordingly, **Ralph Webster** will be our new treasurer starting about October 1982. We agreed to hold our 50th class reunion in Newport, R.I. or on Cape Cod. **Phil Dreissigacker** has arranged for six extra copies of the class picture taken at the reunion to be sent to your secretary. They are available to anyone who has had second thoughts on his desire for a picture at a cost of $5.50 each on a first come first served basis.

Charles Dierksmier, Box 197, Wilton, N.H., retired in 1979 from Abbott Machine Co. in Wilton, a manufacturer of textile machinery. He was plant manager and director. After graduation in 1937 he worked for U.S. Steel and then Reed Prentice, both in Worcester, Mass. In 1944 he joined Abbott Machines and spent the next 35 years there. Charles and Mary spend summers in Plymouth, Mass., five months in Englewood, Fla., and four months in New Hampshire. Their main hobby is fishing and Charles operates a 27-foot cabin cruiser in Plymouth and a 16-foot outboard motor boat in Florida. They also play golf and bridge. . . . **Tom Hallenbach**, 1720 Wildwood Rd., Toledo, Ohio, worked for Baker Brothers, Inc. (manufacturer of machine tools and high speed automatic compression molding machines), for much of his working career. Baker phased themselves out of all manufacturing and product lines in 1970. For the next five years Tom acted as a consultant to the last president of Baker Brothers and then acted as a consultant for Oil Gear Co. of Japan, providing information on the hydraulic industry in the U.S. He retired in 1980 to devote time to a study of the history of the early glass industry in Toledo, Ohio. Wife Peg continues to be involved with church music and the Wellesley College Club. Son George is in telecommunication with Emory Inc., Stamford, Conn. He and wife Grace are parents of the only grandchild, Robert, age three. Son David, Harvard '69, is involved in computer software creation with a small software company in Rochester, N.Y. Daughter Julia, College of Wooster, Wooster, Ohio '77, is married to Edward Badger, a research pharamacological chemist with Park Davis Co., Ann Arbor, Mich. Julia works for Bechtel in storage and retrieval of microfiche and computer data of purchased items.

I regret to report the death of **John M. Simpson, Jr.**, July 19, 1981. The address is 2350 Shadow Oaks Rd., Sarasota, FL 33582. Jack's wife Verginia wrote, "We were with you on the 40th and planned on the 45th."—**Lester M. Klashman**, Assistant Secretary, 198 Maple St., Malden, MA 02148 and **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

39

Hans Bebie retired from Boeing and reports that retirement is a strenuous activity. At a reception for Mary and **Jim Barton**'s son Keith, the Bebies met Nancy and **John Alexander** who recently returned from a three-year sailing trip to the South Pacific. While skiing in eastern Oregon the Bebies met Don and **Jean Sevenson**. Jean (Jean Wynkoop) asked for news of **Gail Snow**. Readers who have such news are invited to send it to **Hans Bebie**, 2165 Killarney Way, Bellevue, WA 98004.

Theron S. Curtis retired from the First National Bank of Boston where he was vice-president in the Trust Investment Division. Theron lives in East Falmouth where, these days, he emphasizes sailing, carpentry, puttering, and tennis.. . . **Burton Rudnick** is developing industrial and commercial real estate in the greater Boston area. Burt's son-in-law is Edwin Arripol, M.I.T. '74 and Sloan School '75, who is thinking of enrolling his son (Burt's grandson) in M.I.T. 1999! . . . **Richard Feynman** took time off from theoretical physics to appear in CalTech's annual spring musical, *South Pacific*. The program picture showed Dick in plumed headdress which identified him to be a native Chieftain on Bali Hai. Dick brought rousing cheers as he played the tweti, a native drum. Classmates wanting to know how they, too, can be the life of Tahiti and play the tweti, are encouraged to write to Professor Feynman, CalTech, Pasadena.

We are saddened by news of the death of **Samuel P. Felix, Jr.**, at Carmel, Calif. There were no details.—**Hal Seykota**, Secretary, 1603 Calle de Primra, La Jolla, CA 92037

40

Attendance at the mini-reunion was relatively small, but those who were there thoroughly enjoyed the activities. Attending the Thursday night Pre-Pops Buffet and Pops were Jan and **Jim Baird**, Jeanne and **Ed Bernard**, **Bruce Duffett**, **Maureen Feldman**, **Edith** and **Ed Kingsbury**, Alice and **Norm Klivans** and Phyllis and **George Wolfe**. On Friday morning a special breakfast and meeting for the Class of '40 was held at the Hyatt Regency. **Norm Klivans** outlined his philosophy regarding the 45th Reunion. He recommended a reunion directed toward fun and second career development, since the Alumni Association usually makes a big push for funds during the 50th.

Paul E. Johnson, **Jim Baird**, **Ed Bernard**, **Bruce Duffett**, **Jack Gray** and your class secretary all participated in a brainstorming session for the 45th. A summary of our plans goes like this: Wednesday afternoon and evening—check in at the Hyatt Regency and M.I.T. Thursday—sight-seeing trip to Marblehead, Rockport, Salem area. Thursday evening—Pre-Pops Dinner at Symphony Annex and Pops Concert. Friday morning—breakfast at M.I.T. Friday afternoon—drive to Woodstock Inn, Woodstock, Vt. (arrangements will be made so that everyone has transportation). Friday, Saturday, Sunday—the village of Woodstock is considered to be the most charming in the country. Woodstock Inn is known internationally and is a "Rock" resort. . . . Seminars will be planned on such subjects as second careers, hobbies, family relations for the retiree, etc. Monday morning—departure. Of course, all of this is tentative, and we would welcome any and all ideas, comments and offers of assistance for this 45th Reunion.

The Technology Day luncheon was attended by most of those at the special breakfast, as well as **Dick Macphaul**, **Wally Schuchard** and **Al Wu**. . . . Wally is vice-president of Electro Signal Lab, Inc., in Rockland, Mass., which is a short distance from his home in Hingham. He challenges anyone in the Class of '40 to equal or better the number of grandchildren he has—nine! Any takers? . . . **Al Wu**, vice-president of Li Tungsten Corp. of New York, was chosen to serve a two year term on the Alumni Association's Board of Directors starting July 1st. On May 24, Al received the Distinguished Service Award from the Metal Powder Industry Federation in Montreal, Canada. . . . **W. H. Krome George** was recently appointed a director to sit on the board of the Norfolk Southern Corp., a merger of the Norfolk and Western Railway and Southern Railway. He is presently chairman and CEO of Aluminum Co. of America.

Three internationally known figures—a poet, an architect and an organic chemist—were chosen to receive honorary degrees at the University of Rochester's Commencement on May 9. **I.M. Pei**, whose widely admired structures include the University's Wilson Commons, received the doctor of fine arts degree. . . . I look forward to receiving additional information regarding your activities.—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

42

Thanks to **Carl Zeitz** and **Bob Howard**, the co-chairmen, and to **Bill Denhard**, our ever efficient Treasurer, for a great 40th Reunion. About 56 classmates accompanied by 52 wives and/or guests were present. Weather at Cambridge was superb but at Wychemere between mediocre and miserable. Some played golf and tennis during drizzles while a very few of the hardiest, jogged! The Pops concert was excellent and other organized and unorganized partying was first class. The class gift was presented by **George Schwartz**, speaking on behalf of **Floyd Lyon**, and totaled $1,876,000.

The Saturday night banquet at Wychemere included a two-minute class meeting at which your worthy officers were reelected by unanimous consent for the usual five-year terms, apparently with no time off for good behavior. The banquet featured a song with words by **Bill Devine** set to the tune "A Warrior Bold" and punnishly titled *The Forty-tude of '42*. Super plans are afoot for the 50th. Save the date June Something, 1992!

George J. Schwartz, 1942 class president, presents the largest of this year's class gifts, $1,876,462, to President Gray. To commemorate their 40th Reunion, 61 percent of the class donated. About $1.5 million of this gift will go toward establishing the Class of 1942 Professorship and the Class of 1942 Career Development Professorship. (Photo: Scott Globus, '84)

The Human Side of Productivity

The role of human capital has been "virtually ignored" in our programs to stem declining rates of productivity growth in the U.S., says **Howard J. Samuels, '41**, former undersecretary of commerce who is now president of Howard Samuels Enterprises, New York.

Workers' education, environment, and health are essential elements in high productivity, Mr. Samuels told an M.I.T. symposium on productivity management early last spring. And present federal policies which reduce our commitment to such social goals promise, if continued, "to accelerate the decline in U.S. productivity," Mr. Samuels said.

"While there is now a consensus that we need to invest more in machinery and technology, we have somehow forgotten the value of investing in people's education and earning capacity. . . . Programs to improve the education and skills of people are an investment in the future of the nation," said Mr. Samuels, "not just a debit on the current budget.

"We have neglected the economic role of brain power," he declared.

Congrats to **Jack Flipse** on his election to the National Academy of Engineering. His citation reads, "Outstanding leadership in marine mineral resource exploration, research and development." . . . Note from **Leo Sartori** reports that he has finished his three-year stint with the Arms Control Disarmament Agency in Washington and is back at the University of Nebraska. Leo completed his tour as chairman of the Physics Department there and is happily back to teaching. . . . Retirements include **Bert Clear** as vice-chairman of The Stanley Works, **Roland Danielson** as manager of ship development and sales at Bethlehem Steel's Shipbuilding Department and **Morrison H. Beach** as chairman of the Travelers Insurance Company.

I received three slick and fancy booklets. One was from **Alan Katzenstein**, titled *An Updated Perspective on Acid Rain*, which includes references by **Shep Tyree**. Two were sent by **Bob Rines**: the 1982 report of The Academy of Applied Science and the catalog of the Franklin Pierce Law Center. Bob is president of both.

We have two obituaries this month. **John L. Senior** of Course XVI was the founder of New York Airways. **Bob Knauer** of Course VIII was on the staff of the Plasma Physics Lab at Princeton. Our sincerest sympathy to their wives and families.—**Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY 10605

43 40th Reunion

In order to have a decently sized column this month, I must expand a little on the three news items that came in. **Bill Vallette** has been appointed vice president of New England Training Institute. NETI is best known for its productivity program, Applied Integrated Dynamics, which uses a team approach involving employees at all levels and in all disciplines from factory to office. Bill and his wife, Charlotte, live in Topsfield, Mass. Bill is a fellow, life member, and former national president of the American Institute of Industrial Engineers.

Jim Casserly from Glastonbury, Conn., was remarried in September 1980. He and his wife, June, have a combined family of eight children and one grandchild. Jim retired from United Technologies Corp. as of March 1, 1982, and now occupies himself with hobbies and participation in Elderhostel . . . Another United Technologies stalwart, **Bill Sammons**, was named president of the North American operations of Carrier Corp., a subsidiary of UT. Formerly group vice-president for Carrier's domestic air conditioning business, Bill will now direct both U.S. and Canadian activities.

Jim Hoey says, don't forget the 40th Reunion in '83. **Stan Proctor** says, don't forget the 40th Reunion Gift. I say, don't forget to send in your news.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44 40th Reunion

By now you probably have a well established routine begun at the new year, which for most of us is right after Labor Day. At that time, the vacation season ends and businesses and schools gear up for the coming year. Even retirees notice the change which occurs when the summer crowds disappear and the hectic pace slackens.

The program on Technology Day was devoted to the future of communications and home information systems. The alumnus sitting next to me in Kresge Auditorium summed up the three talks thusly: we've eliminated the need for human interpreters when the computer automatically translates languages. I'm going out right now to buy a computer for my home because I have many uses for it there, and the home use of the computer as a teaching tool will further change our modes of teaching peoples of all ages . . . At the luncheon, Richard A. (Dick) Knight, who originally was the Class of '45 which became 10-'44 and then '44 and who elected to affiliate with the Class of '47 when he received his degree, was voted an honorary member of the Class of 1928 and received a red blazer acknowledging the fact. Dick, who retired at the end of June as Secretary of the Alumni Association, has been replaced by Shirley M. Picardi, the wife of **E. Alfred Picardi**'s son Anthony. Your secretary has been most fortunate to work with Shirley this past year on the Program and Membership Committee of the Alumni Council and feels that she will do a fine job.

Bob Benedict, **Bob Horn**, **Warren Howard**, **Melissa Teixeira**, and **Dick Whiffen** were registered as attendees at Technology Day activities. I spoke briefly with Bob Benedict, who was looking for Warren Howard. I did not see Bob Horn. I had lunch with Bob and Marge Whiffen. They were on their way home from a business trip to Canada and were also visiting their daughter Karen and her husband who live and work in the Boston area. Those who went to Bermuda for our 35th Reunion may remember that Karen was with us then.

I recently met **Frank Chin** on the street in Copley Square in Boston. He said that his wife Rose was typing a paper for their son Roger so Roger could graduate from Brookline High School and enter Syracuse in the fall. . . . I was grateful for the note from **Roland Benjamin** saying that effective July 30th he was retiring from J.C. Penney and that he and Charlotte would be moving to their new home at 7791 Cloverfield Circle, Boca Raton, Fla. He plans to attend the 40th Reunion activities. In the meantime he would appreciate hearing from you if you are in his part of Florida. . . . Your Reunion Committee meets again in August so look in our next column for plans for our 40th in '84.—**Melissa Teixeira**, Secretary, 92 Webster Park, West Newton, MA 02165

46

There must be some ESP going around. Just after sending in last month's *Tech Review* copy mentioning, among others, **Bill Cahill**, darned if I didn't get a nice letter from him claiming that he was alive and well and indeed living in Incline Village, Nev. (531 Silvertip, ZIP 89450, to be exact). He and wife Shirley saw their last fledglings graduate from high school in June. So now what? "Retirement is setting in," he says. It's catching at our age. Bill says he may get to visit us in Denver, since his oldest son, Kevin, practices law here with Shafroth & Toll, the city's oldest firm. I wrote him a warm welcome.

Then as I was about to ship this off, didn't **Jim Goldstein**'s package come through with data on our "missing persons" along with a lot of humorous repartee between him and the Alumni Office. Jim's a "ten" in my book. As promised, to some extent anyhow, I'll continue with our "missing persons Bureau," in hopes one (or more) of you will let us know what you know about class members who seem to have fallen off the edge of the earth. For openers let's mention:

1) **Joseph S. Apelman, Jr.** —LKA* Box 251, Hornsbyville, VA
2) **Robert K. Baker** —LKA Staff Appraiser, USA Corps/Engrs., Rock Island, IL
3) **Leigh A. Brite** —LKA 1818 Laguna St., Concord, CA 94520
4) **Ken Davis** —LKA Stonehill Rd., Pound Ridge, NY 10576

*LKA Last Known Address

OK. Got the idea? Put on your Sherlock Holmes hats and get with it.

Other than this, there's a trickle of bits. **John Norton** says that he and Priscilla are still in Greenville, S.C., where he's manager of test operations at G.E.'s Large Gas Turbine plant. Their son, John, is State's Attorney for Maryland's Dorchester County and their daughter, Linda, is married and living in Jacksonville, Fla. Two granddaughters have ensued. . . . **Doug Crinklaw** (USN Retired, I assume) is now a full time avacado farmer out in Fallbrook, Calif. (Box 827, ZIP 92028). I wonder if John has a fabulous guacamole recipe?? . . . **Joseph Bates** was just elected executive vice-president of allied products for ALCOA in Pittsburgh, Penn. For my own and Bettie's parts, we were relieved and somewhat awed at our son Aaron's wedding in Columbus, Ohio, June 5th. We trundled out in Bettie's '78 Colt to mingle with Columbus Society, feeling like country cousins. We were treated royally by everyone. Take care; keep in touch.—**Jim Ray**, Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

47

I almost didn't make it home on Sunday from our reunion windup brunch at Quincy Market. I may live the closest of any, but that day turned out to be the celebration of Bunker Hill Day, which is to Charlestown what Bastille Day is to Paris. The parade almost swept me away. 72 classmates, spouses, guests, and children (children by virtue of birth, not age) gathered in June for the reunion of the century. A list of those who attended is available from *Technology Review*. The only thing that will possibly make our 40th surpass the 35th will be the additional hundreds of you who will be there.

Already chiefs have been chosen, goals set, and plans are underway. **Bob Horowitz** has agreed to be chairman of the event, and **Harl Aldrich** reunion gifts chairman. They agree with **Claude Brenner** (did I detect a slight bulge in Claude's cheek? Don't be too sure . . .) on the goals for our 40th Reunion class gift, to wit: two chairs, five career development chairs (half-price chairs), and one building which will be a dormitory with 1947 rooms. **Don Van Greenby** has started the ball rolling by contributing a scholarship in memory of his parents (would you like to make that a nice dormitory, Don?). Plan ahead. Encourage one of your children to move to the Boston area sometime in the next five years and you will have a double reason for coming in 1987. (Also a cheap place to stay.)

Byron Lutman sent his regrets that he could not attend the 35th (he didn't want to miss his youngest child's wedding) but is looking forward to the 40th. Byron is general manager of the Electrical Drives Group of Reliance Electric in Cleveland. . . . Edith and **Mitch Keamy**, in the Denver area, had also hoped to come, but business intervened. Their youngest is at Colorado College; the oldest is an anesthesiologist with a fellowship at Massachusetts General Hospital (see that he stays until 1987, Mitch), and the next older daughter is in her last year of medical school at Brown. Mitch is "chief executive officer of Haaspleshire Energy, a general partnership in Wyoming formed to convert coal to gasoline and one of the awardees of the U.S. Synthetic Fuels Corp. for advanced consideration for financial assistance. It's a grand project of some national interest which I expect you'll hear more about." . . . **Lena Sutera Norman** didn't make it either, but sent a lively brochure describing her work as an artist, working in the Mule Alley Art Center, Fort Worth, Tex. She specializes in sculpture and painting and sells a bronze beaver for $55, plus tax. (Not THE Bronze Beaver, silly.)

A timely note (but maybe not in October) from **Harvey Miller**. He is vice-commodore of the Aleppo Shrine Yacht Club and was in charge of the 1982 boat parade which followed the U.S.S. Constitution on her annual turn-around constitutional in Boston Harbor on the 4th of July. . . . **Robert Balluffi**, professor of metallurgy at M.I.T., has been elected to the National Academy of Science, the highest honor that can be accorded an American scientist or engineer. . . . **John Ebersberger** is now the proud grandfather of three, including twins born on their grandmother's birthday. He is starting his third year as an electrical inspector for the N.Y. State Public Service Commission doing field inspection work in gas and electrical meters. He is also trying to protect consumers from indifference on the part of the utilities.

Ginny Grammer rejoices that her children have all been in the Boston area for the last couple of years, having come together from points as distant as Sioux City and Sao Paulo. Son Charles, assistant technical director at the Arena Theater at Tufts this past year, will be at Yale by the time this comes out, in a three-year master's program in theater tech. Margaret's son Raphael and Charles' daughter Megan bring the grandchildren tally to three. Ginny did much of the work on the Terrapin Tutorial Manual for Logo, now available on the Apple II, soon to be available on

other micros. . . . **Bill Archibald** is a hydraulics engineer working on large centrifugal pumps for the Worthington Group, McGraw-Edison Co. Daughter Penelope was finishing college in Utah this summer, Robin attends Madison College in Virginia, lives near Boston (are you sure, Bill?), and Leslie is at the University of Wisconsin.

Jack Rizika's letter to **Mort Loewenthal**'s mother was read at the reunion. Jack donated a garden of 162 trees in the Jerusalem hills in Mort's memory, in the name of the M.I.T. Class of 1947. . . . **Charles Brooks** has retired and lives in Hatboro, Penn. Daughter Deborah is married to a CPA and has two children. . . . **Len Winship** reports that he owns two Baskin-Robbins Ice Cream stores in Fairfax, Va. . . . **Stan Cobb** is mechanical process superintendent of spinneret manufacturing at E.I. duPont—Textile Fibers—in Martinsville, Va. He is active in the Boy Scouts and the Piedmont Arts Society, and a church elder. His two daughters and one grandson live in Richmond, Va.; wife Libby teaches piano. A Bermuda vacation is on their list, and Stan also plans to purchase a PERSONAL computer, despite Nick Negroponte's contention that there ain't no such animal. Make it an Apple II, Stan, and you can use Logo . . . PLEASE, ALL YOU REUNION ATTENDEES WHO DID NOT TURN IN YOUR COMPLETED QUESTIONNAIRE: send it to me, please.—**Virginia Grammer**, Secretary, 62 Sullivan St., Charlestown, MA 02129

48

Denny McNear was recently elected president of the M.I.T. Alumni Association. He is the first president of the Association who is from the West Coast. Denny gave his acceptance speech on Technology Day in June. After lunch I asked him for news about his family. He first met his wife, Margaret, in Houston. They live in Marin county (north of San Francisco) with their three sons. Their oldest son is a senior in high school, and he recently visited Yale and Wesleyan; Denny doesn't expect this son to enter into engineering. Another son is a high school sophomore and their third son is an eighth grade student. Margaret is active as assistant coach in several sports at the grammar school. The family is active in competitive swimming. Denny's father grew up on the West Coast and during World War I, he stopped in New Jersey on the way to France. Friends had suggested that Denny's father just had to meet a lovely young lady who lived in New Jersey. The meeting took place, and after the war they married. Denny is a third generation M.I.T. graduate. The Alumni Association has planned the annual Alumni Officers Conference to meet in San Francisco in September. Denny is looking forward to this meeting, which will occur while he is president of the Association. Denny has been a member of the M.I.T. Corporation since 1977. He is president of the Southern Pacific Transportation Co.

Before lunch on Technology Day **Dick Berry** described his family activities. His wife has a law degree, and she has been an elected representative to the Connecticut legislature. This fall she will be acting superintendent of schools in a town near their hom in Rogers, Conn. Their son graduated from Yale Law School. After his daughter completed an M.I.T. degree she went to law school. Dick is vice-president of research at Rogers Corp. . . . Jean and **Warren King** went to a seminar in Rockport, Maine, after Technology Day. Their daughter is an experienced nurse, and she works for Baxter Travenol in the health care areas. Their son is director of a school of delinquent boys. Warren sold his consulting business and is able to take a few days for golf for the first time in years. He has bought a second home in Palm Springs, Calif.

Bob Ormiston continues with the Bell Systems' Long Lines operations. He has varied experience in operations and technical management. Mostly he has concentrated on the technical side. He has prepared computer programs that improve operating efficiency, trace maintenance problems and supervise equipment utilization. Bob has been active in the M.I.T. Club of Northern New Jersey. After lunch, Bob and I toured the campus. . . . **Bill Lyons** of Hamden, Conn., is active in the M.I.T. Club of New Haven. He had been president of that club. His firm designs the electrical and mechanical systems for condominiums and apartment buildings. When Bill was an undergraduate at M.I.T. he was married and lived off campus. As a result he was not involved in school activities.

The warm-up cocktail parties for the 35th Reunion are continuing. In April, Judy and **Graham Sterling** were our hosts. In May, Rose and **Leon LaFreniere** did the honors. In June, Joan and **Al Seville** invited classmates to their home in Lincoln, Mass. The badminton game was rained out, but 20 couples enjoyed the party in the playroom. Invitations were sent to classmates in the towns surrounding Lincoln and several classmates who had not been active decided to join the party. Joan commented that several classmate's wives enjoyed the opportunity to meet one another in the relaxed atmosphere. Joan and Al are leaving this week for a month in Hawaii. They will watch from the beach while their kids do the surfing.

Fred Dunmire is still at Grumman (since '48 graduation) as director of finance, Marketing and Advanced Technology Department. His wife Margaret is a special education teacher. #1 son, Clarkson, is at Garrett Airresearch. #2 son is a sophomore at Clarkson (both mechanical engineers). Daughter Karen is graduating from high school this year. . . . **James T. Smith**, president and chief executive officer of Magnavox Government and Industrial Electronics Co., was named a director.

Frank Heger and an associate received an award of $3,000 in recognition of their outstanding engineering contribution to the design of Spaceship Earth, the theme pavilion for Disney's Epcot Center in Florida. The structure is a sphere 160 feet in diameter supported 20 feet above the ground on six legs. The award was made by the Lincoln Arc Welding Foundation of Cleveland. Frank's firm is Simpson, Gumpertz, and Heger, Inc., an engineering firm in Cambridge.

The award was granted by a panel of professionals in welding design, engineering, and fabrications for achievements in reducing costs, conserving material, time, energy, improving productivity, performance or appearance through using arc welding.

The Reverend **C. F. Neely** is rector of St. James Episcopal Church in Cincinatti, and is chaplain to Hospice of Cincinnatti.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806 (401) 245-8963

1949 Beaver rug by Mal Kurth

49

Wedding news: **Dave Hardin** married Paula Cantwell on August 1 in his home town of Wilmette, Ill. We were sorry to hear of his wife, Diane's, passing last year, and are now so happy for Dave. . . . **Mal Kurth** promised to "hook" us a 1949 Beaver. We thought he was full of "Good Ole Bermuda" when he announced this during our last island reunion. But, no, he had; he did; he sent a picture to prove it; and he has volunteered to send it to our next alumni day meeting or our next reunion. Mal says he and Doris are both anticipating next year's retirement from General Electric.

Mary Cretella reports that she is a project leader in the research division at Mobil Tyco Solar Energy Corporation. . . . **Edward T. Thompson**, editor-in-chief of *The Reader's Digest*, has been elected to the M.I.T. Corporation. . . . **Cary J. King, Jr.**, died earlier this year. We extend our sympathies to his family. . . . The news is short this issue, but so also is the time till our next five-year reunion (our 35th in 1984). Please write and tell me what you would like to do, where you would like to go, and also what you are doing now.—**Paul E. Weamer**, Secretary, 331 Ridge Meadow Dr., Chesterfield, MO 63017 (314) 576-9919

50

William D. Walther has been named vice chairman of steel wheels for trucks and trailers for the Dayton-Walther Corp. of Dayton, Ohio. . . . **Robert W. Mann**, Uncas A. Whitaker Professor of biomedical engineering at M.I.T., was among the 60 new members elected to the National Academy of Sciences. The election was held on April 27. Election of membership in the Academy is considered to be one of the highest honors that can be accorded an American scientist or engineer. The National Academy of Sciences is a private organization of scientists and engineers dedicated to the promotion of science and its use for the general welfare.

President Reagan has appointed **Carol E. Belton** to the Peace Corps Advisory Council. Carol is the vice-president for special products marketing of Tenneco Oil Co. in Houston, Tex. He started his career as a chemical engineer in 1950 with American Oil in Texas. Four years later, he joined American Petrofina in Big Springs, Tex. He first came to Tenneco as a chemical engineer in 1961 and transferred to Ashland Oil Co. in Houston in 1967. He returned to Tenneco in 1973, becoming vice-president about two and a half years ago. Active in the Harris County Republican Party since 1962, Carol has been a member of the State Republican Executive Committee since 1976. He was an alternate delegate to the 1976 Republican National Convention in Kansas City and co-chaired the Reagan for President Committee in Congressional District Seven in Texas in 1980. He and his wife, Geraldine, reside in Houston. They have four children.

Margaret Coleman was among 160 women who attended the conference for women in engineering, held at M.I.T. in April. Can women engineers compete with their male counterparts on a reasonably straightforward basis? Says Margaret, the discrimination may be less blatant but it is there—a powerful block to women pursuing a career in engineering. To provide some support for each other, the Association of M.I.T. Alumnae and the Society of Women Engineers sponsored the April conference. Most of the women who attended were from the Boston area and they focused on exploring career options and strategies for successfully pursuing those options.

A new book entitled *National Service, Social, Economic and Military Impacts* was co-edited by **Donald J. Eberly**, National Service Secretariat. It is a comprehensive study of national service that assesses its political, economic and social feasibility from both an historical and international perspective. . . . **Eli Goodman** was recently presented a certificate from James Edwards, Secretary of Energy, in recognition of his outstanding service during the Combined Federal Campaign. Eli has resided in Chevy Chase, Md., since joining the predecessor agency to the Department of Energy, the U.S. Atomic Energy Commission, in 1965.

I'm sure those contributors to the Class of 1950 Scholarship Fund would be interested in the following letter which was sent to me by Donald M. Jassowski, Class of '57:

"I wish to express my appreciation to the Class of 1950 for their extraordinary generosity in subsidizing the interest for the Parent Loan Plan. My son has just completed his first year at M.I.T., with the major portion of his expenses covered by the plan. I was extremely pleased to be informed that the Class of 1950 has covered the interest charges for for descendants of M.I.T. alumni. Needless to say, the cost of sending a student to M.I.T. these days is difficult to handle. The Parent Loan Plan has made it practical, though the monthly payments are a constant, very pressing reminder of the fiscal reality. The fact that these payments will be completed significantly sooner with your aid is a relief to my wife and me. It will make it possible for me to

This Class of 1952 line-up includes outgoing president Arnold Kramer (left), outgoing reunion chairman and new president Arthur Turner (middle), and treasurer Stanley Sidney.

contribute some of the deferred payments to the alumni fund when the plan is paid." This letter shows the good work we are doing and I hope that all our classmates will continue to support and even increase their donations to this very worthwhile fund.—**John T. McKenna**, Secretary, 1 Emerson Place, Apt. 11H, Boston, MA 02114

52

Our 30th Reunion has come and gone. **Art Turner**, no longer responsible for the class notes, very kindly "output" the following copy to the list device of his personal computer:

"Reunions may come and go, but seldom will there be one so closely fitted to a brief spell of dry weather. We closed our 30th with only hours to spare before the rain. From the buffet pre-Pops in the Summit Room of the new John Hancock Building with its tremendous view, through the traditional M.I.T. Night at the Pops, including the singing of "Arise ye sons of M.I.T.," to Irish coffee in the new dorm at 500 Memorial Drive, we had a tremendous first day. (The facilities at 500 Memorial Drive are a far cry from the Building 22 of our freshman year, and rival the Hyatt Regency next door.) M.I.T. came through with a most interesting and timely program on personal computers at Technology Day. Those of us who missed part of the program regret not having heard it all. Tech Day luncheon was marked by the recognition of **Ray Wong**, of Kuala Lumpur, Maylaysia, who came the greatest distance to attend the reunion.

"Our formal evening at the Meridien Hotel, formerly the Federal Reserve Bank of Boston, was great fun, with dinner and dancing, and class elections. (Results of the elections are given below.) One of the most outstanding clambakes in my experience came the next day, courtesy of Wentworth-by-the-Sea in Portsmouth, N.H. Meatier lobsters there may be, but the Wentworth's will do! Finally, we had a brunch in M.I.T.'s Pierce Boathouse. Attendance, at 120 persons, was lower than we had hoped, but having 60 classmates return was as good a showing as most of the other reunion classes. All enjoyed the activities, and we look forward another five years to the 35th."

The reason that Art no longer writes the class notes is that he is now class president. **Stan Sydney** continues to serve as class treasurer, **Dick Heitman** is the 35th reunion chairman, and **Dick Lacey** is now secretary. . . . A selection of even greater moment is the choice of **John R. Myer** as head of M.I.T.'s Department of Architecture. In addition to his teaching, Professor Myer has been founder and president of an architectural firm, Arrowstreet, Inc., in Cambridge. In addition to designing buildings, he has been responsible for several urban design projects, including the design for the master plan of the Boston waterfront and the Washington Street Mall in downtown Boston.

Leon M. Polinski, an expert in catalysis for coal liquefaction, died February 15, 1982. After graduating from M.I.T. in course X, he received a master's degree from the University of Cincinnati and a doctorate from Brooklyn Polytechnic Institute. He worked for American Cyanimid Co. in Bridgewater, N.J., and Engelhard Minerals and Chemicals Corp. in Edison, and then moved to Pittsburgh three years ago. At the time of his death he was supervisory chemical engineer in charge of catalysis development for coal liquefaction at the Pittsburgh Energy Technology Center of the U.S. Department of Energy. He is survived by his wife Sally, a daughter Linda, a son Adam, and his mother.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

54

"Good evening, Mr. and Mrs. America and all the ships at sea. . . ." We have heard from usually reliable sources (**Bob Rohner**) that **George Schwenk** was recently married. More details will be reported in our next issue, but in the meantime we extend our best wishes to George and his bride. . . . **William Wernsing**, president of Williams Laboratories, Ithaca, N.Y., wrote to advise that his firm recently introduced the Byte-Writer, the lowest-cost letter quality printer, for small business and personal computers. . . . **John Graham** is a candidate for reelection as a selectman in North Andover, Mass. John is a program manager at Avco Systems Division, Wilmington.

Bob Lait, who has worked for many years as a chemical broker, recently formed his own company, Chemetals International, Inc., in Houston. Good luck to Bob in his new venture. Bob wrote that he noticed a picture of one of our classmates in a Houston newspaper. It seems that this classmate, who lives in Groton, Mass., and teaches chemical engineering at the University of Lowell, attended their commencement ceremonies (which were held outdoors in pouring rain) wearing a snorkel, diving mask, and flippers. "Thank heaven," Bob wrote, "that M.I.T. wasn't mentioned."

Congratulations to **John Gusemer**, who received his pilot's license last year and has already accumulated over 250 hours. In this era of inflation, 250 hours may not sound like much, but to a landlubber like me, over ten days of flying represents at least a case of burp bags.—**William Combs**, 120 West Newton St., Boston, MA 02118; **John Kiley**, 7 Kensington Rd., Woburn, MA 01801; **Louis Mahoney**, 52 Symor Dr., Convent Station, NJ 07961; **Dominick A. Sama**, 28 Chestnut Hill Rd., Groton, MA 01450

55

Our supply of news items seems to be dwindling. We know you're out there, and we would appreciate hearing from you—particularly from those of you who have not graced these pages in recent times.

Among the few offerings for this month, we learn that **Dr. Robert Dyck** has been the director of International Programs at Virginia Tech since 1976. He is serving this year as the chairman of the Steering Committee for International Affairs of the National Association of State Universities and Land Grant Colleges. Bob's daughter Henrika is a junior at Hollins who studied in Paris during the past school year. . . . Your New York commentator recently had occasion to talk with **Joe Saliba**, who is still keeping IBM's Latin American and Far East subsidiaries in business. Joe is engaged in market research and forecasting activities for that little known outfit. In addition, Joe is active in a number of outside business activities, including a small publishing operation which has marketed personalized calendars and the like.

Walter G. Shifrin, about whom we have written in the not too distant past, has recently been named the manager of the St. Louis office of CH2M HILL. In reply to our inquiry, Walt advises that CH2M HILL is an acronym developed over the past 35 years for the principal partners of his consulting firm. Not very romantic, but it certainly has trademark significance. Beyond that fact, Walter reports that he and his wife Jenny have two children, Lisa and Jeffrey, both of whom are students at the same high school from whence he graduated a few years back. . . . We have a brief note from **Peter C. Tosini**, another refugee from Forest Hills, N.Y. Peter reports that he has just finished his dissertation at Georgetown University, and is now a "card-carrying" economist. Congratulations, Doctor.

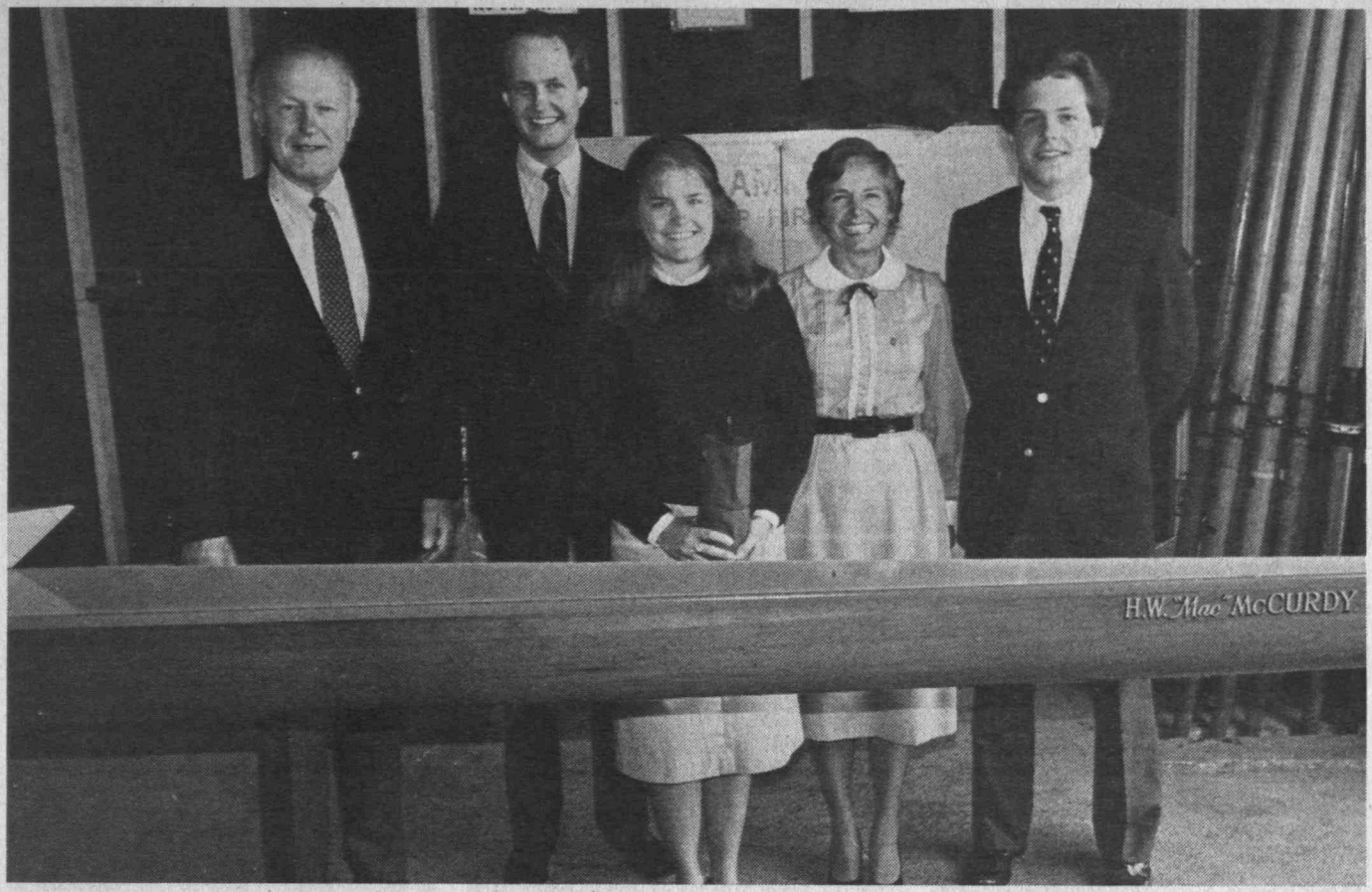
I find that I have been derelict in passing on the doings of two members of our class, **Dave Brooks** from Ottawa, Canada, and **Samuel C. Goldman** from Houston, you know where. Dave published a book on Canadian energy policy last year, *Zero Energy Growth for Canada*, and continues to be active in the energy conservation field. On the other hand, Sandy organized a new company, Life-Tech Instruments, Inc., involved in medical electronic instrumentation in the field of urodynamics and neurologic measurements. Our apologies to both Dave and Sandy for the tardy reports—please drop us a line to bring us up-to-date.

Finally, we must report the untimely death of **Stephen T. Fessenden** in West Peabody, Mass., several months ago. Steve had been employed by AVCO in Wilmington, Mass., for the past twenty years, most recently as director of its Carbon and Carbon Materials Division. He leaves his wife Shirley, and three children. Our condolences from the class to his family.

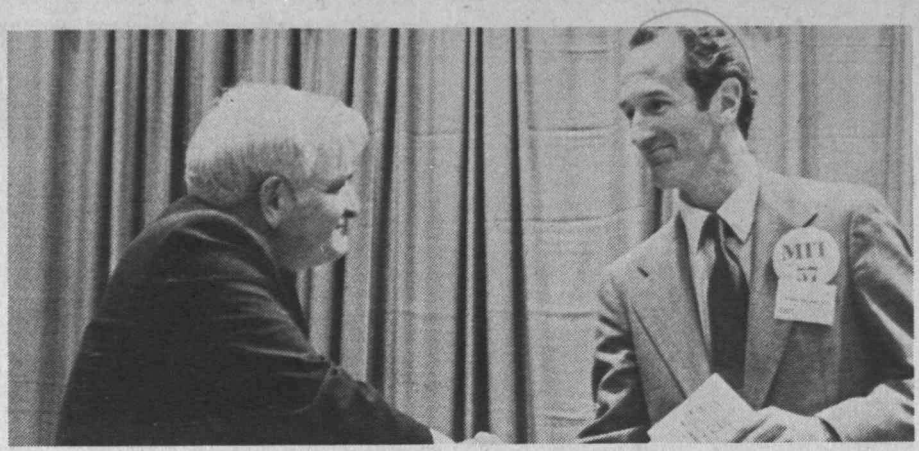
We look forward to hearing from you.—Co-Secretaries: **Marc S. Gross**, Winding Road Farm, Ardsley, NY 10502 and **Allen C. Schell**, 19 Wedgemere Ave., Winchester, MA 01890

56

The mail bag contained quite a few news releases which announced to the world in general, and by proxy to the Class of 1956, that a number of classmates are being rewarded for past efforts. Here is this month's Honors List: **William R. Dickson** was appointed senior vice-president of M.I.T. with responsibility for the coordination of administrative operations across the Institute. Bill has had the responsibility since May 1981; the title came a little later. . . . **Elwood S. Wood** was named president of the Polyfibron Division and corporate vice-president of W.R. Grace & Co. Woody and his wife, the former Jean Abbott, reside in Acton, Mass. . . . **John W. Patierno** was recently named vice-president and general manager of the newly formed Advanced Systems Division of the Northrop Aircraft Group. . . . **Norman Siegler** was promoted to the position of senior vice-president of finance and controller of



Three new eight-oared shells joined the M.I.T. fleet in a single day last spring. President Paul E. Gray, '54, led his family in christening the Paul E. Gray; *James G. McCurdy, '48, and his family stood in for Mr. McCurdy's father, Horace ('22), to dedicate the* H.W. "Mac" McCurdy; *and Edna B. Smith, wife of recently-retired Ross J. Smith, former director of athletics, christened* The Ebee *while joined by Cornelius ('58) and Mrs. Peterson (Mr. Peterson is a member of the Corporation Visiting Commitee for Athletics). (Photo: Ken Cerino)*



Jordan L. Gruzen, '57, reunion gift chairman, was delighted to present the largest 25th Reunion gift in M.I.T.'s history—a total of $1,664,739. Of this total, $325,384 will establish the Class of 1957 Career Development Professorship. About 65 percent of the class contributed to the class gift. (Photo: Scott Globus, '84)

Ideal Toy Corp., Hollis, N.Y. He joined Ideal in 1971 as corporate controller. Norman, his wife Marlene, and their four children (Ann, Eric, Lynn and Robert) live in East Hills, N.Y.

On a different note, the February 1982 issue of *Chemtech* contained a guest editorial by **Albert Hahn** entitled "Reflections on the Future of the Process Industries," and which I recommend highly. Al is now a senior engineer at BEICIP, the consulting affiliate of the Institut Français du Petrole in Rueil-Malmaison, which is in the Parisian suburbs. He is also a consultant to a number of chemical companies in Brazil, and the author of *The Petrochemical Industry*, published in 1970.

Roger Borovoy was quoted in the June 25, 1982 *New York Times* article on trade ethics in Silicon Valley. This article followed the arrest by the FBI of representatives of two Japanese electronics companies for the alleged theft of IBM trade secrets. When asked to comment on the operations of listening posts established by Japanese companies in Silicon Valley, Roger, who is vice-president and chief counsel for Intel Corp. of Santa Clara, Calif., noted that their function is to "read everything in *Electronic News*, get data sheets from competitors as soon as they are printed, attend technical conferences, buy the first one of every new product introduced and listen in bars for engineers talking about any new products about to be introduced." He adds, "I consider all of that legitimate. Not nice, but legitimate."

I would like to note in closing that any information provided to the undersigned about any past, present and future activities of members of the Class of 1956 would not be deemed inessential, and would get immediate recognition in this column.—Co-Secretaries: **Robert Kaiser**, 12 Glengarry, Winchester, MA 01890, (617) 729-5345 and **Caroline Disario Chihoski**, 2116 W. Davies Ave., Littleton, CO 80120, (303) 794-5818

59

It's rather embarassing to receive a class notes reminder from the *Technology Review* staff and to discover that two or three issues have come and gone without my having found the time to contribute my column. So if this news pertains to you, and you remember it only dimly (by the time you read this it could be six to nine months old), my apologies to you. However, in the past several months, I have taken some lengthy business trips to the West Coast, Texas and Japan—all of which seemed to place me away from a typewriter at deadline time.

In any event, here's the news. **Michael J. Nash** has been named executive vice-president and chief executive officer of the Crestek Group, comprised of IMM Energy Services and the two technology subsidiaries of Technology, Inc. . . . **Martin J. Gruber** is professor of finance at the NYU Graduate School of Business and has just had his seventh book, *Modern Portfolio Theory, Investment Analysis*, published by John Wiley. He has also been recently elected to the Board of Directors of the American Finance Association, and is a director of the newly formed "Standby Reserve Fund, Inc." Martin lives in Ridgewood, N.J., with his wife Ellie, and three children, Jon (16), Stacey (13), and Joelle (5). . . . **John J. Erglis** is presently living in Korea and is employed by Kampsax International as project manager for construction supervision of highway improvemment programs.

Robert D. Doleman writes that he is "still coasting along at work, volunteering, and getting an M.B.A. Plans to enter Human Resources work in Honolulu

Wanted: New Policies for the New Era of Knowledge

U.S. policy, geared to helping capital-intesive "sunset" indsutries and building national defense, is working against the nation's fragile leadership to "sunrise" knowledge-intensive high-technology industries, says **Raymond S. Stata, '57,** president of Analog Devices, Inc., of Boston.

Current efforts to stimulate capital formation and to curtail federal support for education in order to strengthen defense and to balance the national budget are absolutely counter-productive, Mr. Stata said in keynoting Electro 1982 last spring—with over 40,000 registrants, the largest high-technology meeting ever held in Boston.

What high technology needs, said Mr. Stata, are not tax incentives for investment but lower taxes on capital gains, higher tax credits for research and development, and more government help to provide the people to do the job and the basic knowledge on which they draw.

"High-technology firms place a value on human capital and in particular on technical talent which is the raw material that feeds the growth of this industry," declared Mr. Stata. "In the context of tomorrow's economy, it makes more sense to invest in education than in steel."

New Priorities for a New Era

The present net growth rate of the electrical engineering workforce in the U.S. was put by Mr. Stata at about 2 percent a year. Meanwhile, the growth of high-technology electronics industries may be as much as 5 percent a year—and the comparison reveals "a problem by any scenario." His conclusion: "It is imperative that we adopt a long-term growth strategy for the nation's engineering education capacity."

What to do? Colleges and universities are already beleaguered by problems of underpaid faculty and obsolescent equipment. Industry can help with research support and facilities, by using engineers more efficiently, by encouraging engineers so that they make long-term committments to the profession, by helping engineers overcome technical obsolescence, by giving senior technologists power in the organization to influence corporate policy and strategic decisions. . . .

Any careful analysis of needs and funds puts the basic problem in Washington, said Mr. Stata—the only place where adequate resources can conceivably be found.

"What we need from the federal government," declared Mr. Stata, "is leadership that recognizes the importance of technical innovation. . . . We face a formidable challenge in shifting our national policies to better accommodate the economic transition now underway."

upon graduation in May (1982)." . . . **George Barnett** has become a member of the law firm of Mazur, Carp, and Barnett. He writes that his office is located in the lower tip of Manhattan from whence he gets "the opportunity to survey **Phil Richardson**'s domain and even have lunch with him from time to time." . . . **Kent Kresa** has been named group vice-president of Northrop Corp.'s new Aircraft Group. And **F. Hudnall Christopher** has been named senior vice-president, manufacturing, of R.J. Reynolds Industries, Inc. Kent is located in Los Angeles and Chris is in Winston-Salem, N.C.

About five weeks ago, when I was in the midst of my trip to Japan, the following letter was sent by **Frank Koppelan**. I really appreciate his taking the time to write such a lengthy note, so I am including it in its entirety: "I had the opportunity to return to M.I.T. in 1971 and spent the period from 1971 to 1975 studying for a doctorate in transportation systems analysis in the Civil Engineering Department. The department had changed dramatically during my absence. Most of the senior faculty had retired. Many of the junior faculty from our undergraduate days had moved into the senior faculty ranks. The department is an exciting one, adjusting to the times with innovation in areas of interest and teaching methods. I was appointed associate professor of civil engineering at Northwestern University in the fall of 1975 and was promoted to professor of civil engineering and transportation in the spring of 1982. I enjoy being in the academic world and living in the Chicago metropolitan area. Periodically I see **Marvin Manheim** who is a senior member of the transportation faculty in the Civil Engineering Department, **Martin Zimmerman** who is a successful financial entrepreneur in the Chicago area, and **Victor Mashaal** who is a successful builder, developer and real estate operator with headquarters in Montreal."

G. Richard Huguenin has founded a new company, MilliTech, which will develop, manufacture and market components and systems for use at millimeter and submillimeter wave lengths. He is located in Amherst, Mass. . . . **Robert F. Manlove, Jr.**, is chair of the Anthropology, Sociology and Psychology Department of the City College of San Francisco. He was also elected president of the faculty (Academic Senate) in May, 1981. . . . A news note and a request comes from **Joseph Seidel**. He recently joined American Standard in NYC as director of strategy development. He spends weekends flying a newly acquired sailplane and (here comes the request) would like to hear from other M.I.T. soaring enthusiasts. . . . **Herbert H. Champlin** has been named a director of the Oklahoma Gas and Electric Co. in Oklahoma City. Herb is also president of Champlin Exploration, Inc., and chief executive officer-chairman of the First National Bank and Trust of Enid City, Okla.

One of our classmates has been elected to the National Academy of Engineering. **Gilbert Y. Chin**, who is head of the Physical Metallurgy and Ceramics Department at Bell Labs, was elected to membership in February. . . . **Robert C. Voight** writes that he has been chief civil/structural engineer with the C.W. Nofsinger Co. of Kansas City since June, 1981. (My notes aren't that old—I just received notice about three weeks ago.) . . . Believe it or not, I'm almost at the end of the news backlog—only four or five slips of paper to go.

Albert W. Girotti is currently associate professor of biochemistry at the Medical College of Wisconsin. He is quite active in research projects sponsored by the NIH and NSF in the study of photosensitized reactions in biological membranes. . . . **Barry Altschul** is nearing fifteen years with the equipment division of Raytheon where he is a staff engineer in the Receiver Department. He and his wife Barbara have just completed their second year of participation in the Host Family Program for M.I.T. freshman. . . . **Demos T. Kyrazis** has retired from the Air Force as a Colonel after 30 years of service. He worked on high energy laser weapon development for the past 11 years, and will go to work for R and D Associates, Marina Del Ray, Calif., while continuing to live in Albuquerque. . . . **George T. Haymaker** has been elected international vice president for Alcoa and **Robert S. Harp** is on the board of Vector Graphic, Inc., a manufacturer of microcomputers and developer of software, located in Thousand Oaks, Calif.

And that's the end of the backlog—but since I'm rolling along, let me add a few notes about the Laben family. I'm still with IBM Corporation in White Plains, N.Y., nearing twenty years of service. A new assignment within the Systems Products Division has enabled me to travel to various laboratories and manufacturing plants where I continue to be amazed at the number of alumni I recognize (the ring is distinctive) and the diverse jobs they have. My wife June keeps more than busy as manager of a gourmet food store in Stamford and running a Japanese antique and art gallery. Nancy is now a senior at Smith, having just completed her junior year abroad as a student at Doshisha University in Kyoto, Japan. And Gary is now a freshman at Johns Hopkins. Thanks for bearing with me through first the lack of a column and then through this long long one. Keep the notes coming—they will appear in print eventually.—**Larry Laben**, Secretary, 310 Rockrimmon Rd., Stamford, CT 06903

61

A couple of serious joggers to report on this month. **Grady Harris**, who is now senior vice president at Baxter Travenol Laboratories, is getting ready to run in his sixth marathon! **Dick Cumming** and **John Sullivan** jog three days a week in Wilmington, Mass. Since John is an M.D. Dick feels secure about his care if he falls ill during a jog. John, however, is concerned about what he will do in the reverse situation. . . . **Harry Baya** is more calm during his relaxing moments. He writes that he is into banjo, fiddle, and singing folk music. He goes on the say, "After three years with Merrill Lynch and one at American Express I am now on a six-month program development contract in my apartment with an Apple III. I am divorced (to my horror), a quaker and a two-time ESTer (good stuff!)."

Lots of academic movement these days. **Dick Naylor** spent last Christmas in the Galapagos Islands, ostensibly to look at the geology, but the iguanas and blue-footed boobies kept getting in the way. Now he is back on a sabbatical from his chairmanship of Northeastern's Earth Sciences Department. He is busy visiting colleges with programs in Appalachian geology. . . . **John Savage** is just back from a 10-month sabbatical leave at the University of Paris and the INRIA in Versailles. Now he is, as usual, at the Computer Sciences Department at Brown University. . . . **Omer Prewett** is an exchange professor from Gustavas Adolphus College to Kansai Gaidai University in Hirakata City, Japan, until February.

On the industrial front, **Henri Schnurmann** writes that he is in his 19th year at IBM in Fishkill, N.Y., involved in the testing of VLSI and looking into new approaches for the testing of future products. He is now a senior engineer. The Schnurmanns left New York City 10 years ago to go to Monsey where they are bringing up three kids ranging in age from 4 to 17. . . . **Leslie Bromwell** writes as follows: "After leaving the Boston area in 1972, I started a small geotechnical engineering firm in Lakeland, Fla. Bromwell engineering specializes in waste disposal and land reclamation problems associated with mining, dredging, and hazardous materials. We recently opened a Denver office and I enjoy flying my own plane back and forth."

I got a "press release" written in **Bob Pease**'s own hand, and I quote: "Bob Pease, staff scientist at National Semiconductors, recently designed and built some subminiature temperature-to-frequency converters for the American medical research expedition to Mt. Everest. They weigh less than 1/3 ounce, draw just 20 milliwatts and are accurate to 1/3 of a degree from −40° to +105° F. When the climbers reached the summit the temperature was −8.8° C = +16.1° F, and the converter was purring along at 3.12 KHz. The climbers did special exercises at the summit and at high camps for medical research." Thanks, Bob! He also sent along a couple of articles written for *National Semiconductor* and a nice drawing in his own hand of an enthusiastic climber. . . . Also reporting from Silicon Valley is **Sandy Wagner** who says that he is running the Computer Education Program for the Santa Clara County schools. The Wagners—wife Linda, Alice (12), and Mark (7)—live in Menlo Park.

Avram Kalisky writes: "After nine years with the Israel Ministry of Industry I am taking a leave of absence preparatory to returning to industry—this time in Israel. I have founded two companies: EITAM, Ltd., management and financing, and TELETOKEN, Ltd., developing computerized entry systems. The former is a consulting organization to assist new and small firms engaging in research, development, and manufacturing. The latter is developing a proprietary communications system for which I am project manager. My younger daughter, Ilona, recently received a B.S. in nursing after five years as an R.N. Lyira, my older daughter, is enjoying the last of the Sinai before it is transferred to the Egyptians. Mathew, our youngest, after his three-year stint in the army is working in a farming settlement to the south of the Dead Sea. Esther, my wife, is working at the Jerusalem Music Center."

Jim Macstravic just retired from the U.S. Army after 20 years and joined RCA Government Communications Systems in Camden, N.J., as a member of the Advanced Missions Group. . . . **Joseph Stell** is an architect in private practice in NYC. . . . **Claude Phipps** lives in the Rio Grande Valley town of Nambe, N. Mex., near Santa Fe. He writes that his son David is studying physics at BU and that David's father is a section leader in the Applied Photochemistry Division at Los Alamos Laboratory.

Finally, word comes that **John Sununu** has been bitten by the political bug. Last year at this time he was coming in a close second for the Republican nomination for senator from New Hampshire. Now he is deeply involved in a campaign for governor. The *Claremont* (N.H.) Eagle Times article I have here says that John was seriously considered by President Reagan for appointment as Secretary of Energy in 1980. The article quotes John as saying, "I intend to lead us out of our current fiscal troubles and meet the challenge of the New Federalism." If the election goes badly John will just continue as an associate dean at Tufts College of Engineering. I'll follow the results of the election and let you know what happens.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

62

A letter from **Vito Caravito** says that he and his wife Jo had a great time at the 20th Reunion. He says the success of the reunion was due to the great organization job done by **Fran Berlandi** and his wife. Vito just finished a tour on the Alumni Fund Board. . . . I also received a letter from **Theodore Labuza**, who stayed on the faculty at M.I.T. after receiving his PhD. in nutrition and food science in 1965. In 1971 he went to the University of Minnesota where he is now a full professor. He has written over 150 papers and nine books on shelf-life testing and chemical binding of water in foods (water activity) and has named his 38 foot houseboat "The Water Activity." His wife A. Elizabeth Sloan is director of the Good Housekeeping Institute in New York. He recently pledged for one of the seats in Room 10-250, to commemorate all the classes and faculty meetings he attended there.

Dean E. Eastman, IBM Fellow, has been elected to the National Academy of Sciences. . . . **Tony Mack** is still with Sweetheart Plastics after eighteen years. He is currently director of product and systems development and recently developed the "McDonaldland Express" Happy Meal Package. He was a delegate to the Massachusetts Democratic State Convention this year. His oldest child Chris (18) is at Northeastern University this fall. His other children are Jodi (14) and John (11). . . . **Edwin A. Carlson** has been appointed associate director in the Data Processing Department at the Travelers Insurance Companies of Hartford, Conn. He has been with the companies since 1963 and is a fellow of the Casualty Actuarial Society and a member of the American Academy of Actuaries. . . . **Jerry L. Adams** was re-

cently promoted to professor of physics at Roanoke College in Salem, Va.

Lawrence Salba writes that he, his wife Pam, and their children Benjamin (3) and Leslie (2) are living happily in Farmington Hills, Mich., trying to survive the local depression. . . . **Barry Belkin** is vice president of Daniel H. Wagner Associates, a consulting firm in operations research and mathematics in Paoli, Penn. One of his current projects is to computerize the scheduling of the master rotation and call duty assignments of medical residents. . . . **Jon L. Zellers** recently retired from twenty years of service in the Marine Corps. He was an infantry officer during two tours in Viet Nam, head of the Science Department at the Naval Academy Prep School, and a military manpower specialist in Washington. He is now employed by Decision Systems Associates, a small software development company in Rockville, Md. . . . **W. Thomas Brydges III** has been appointed director-corporate planning of the Marketing and Business Development Division of Corning Glass Works. He joined the firm in 1968.

Finally, I received notice of two books: *Laser Induced Chemical Processes* was edited by our own **Jeffrey I. Steinfeld** and published by Plenum Press. And *Recent Developments in Side-Scan Sonar Techniques* includes a chapter by **Martin Klein** on seabed mapping.—**John Prussing**, Secretary, 21106 Grange Dr., Urbana, IL 61801

63 20th Reunion

Here in southern California the schools which are featured in the sports pages are usually USC and UCLA. So, when I spotted M.I.T. in the pages of the July 11th *Los Angeles Times*, I read the short item with great interest. . . . and I repeat it here for you. Tom Seaver (Cincinnatti Reds pitcher) told the following joke about a Navajo engineer who repaid his tribe for sending him to M.I.T. He introduced electricity to the tribe by putting a lightbulb in the outhouse. Said Seaver: It was the first time anyone had wired a head for a reservation. We're going to have to talk to the Institute's sports information director—surely there are better ways to get our name in the papers. And now, the news. . . . We had several class heroes this month. **Warren Sewall** is practicing medicine in Upper Providence, Penn. and has remained active in M.I.T. activities. Warren interviews local high school students as a member of the M.I.T. Educational Council. . . . **Allen Meyer** is still working at the Office of Management and Budget in Washington, D.C., as chief of the Income Maintenance Branch. Allen has responsibility for social security, public assistance, food stamps, and other programs for the poor. Al says that the past year and a half have been extraordinarily busy and exiciting times for a student of politics and government. Al's wife, Nancy Felipe Russo, is Women's Program Officer for the American Psychological Association and is also active in writing articles and books. Al also reports that **Andy Campbell** is a neighbor of mine, working at the Aerospace Corporation in Los Angeles. . . . Our third class hero is **Alan Bell**, who wrote a long and newsy letter bringing us up to date on his recent activities and reminiscing a bit over the twenty years that have elapsed since we were two freshmen in R.D. Douglass' 18.03 class. Alan is president of a small computer consulting firm, Alan Bell Associates, specializing in human resource information system management. He is also in his twelfth year on the adjunct faculty at the New York University Graduate School of Public Administration, teaching courses in statistics. Al spends a lot of time on the tennis courts these days. In 1965 he won the national intercollegiate table tennis championship (ping pong to us hackers)—singles, doubles, and team events. Following that he retired and now spends spare hours playing tennis with an occasional game of basketball thrown in.

Wow! Three letters in one month—that's almost a column by itself. But there's more. . . . **Elliott Bird** is still chairman of the Math Department at C.W. Post College, and is active in pre-college math education. He is chairman of the Professional Standards Committee of the Association of Math Teachers of NY State. A new activity for Elliott is his involvement with the M.I.T. Academic Council. . . . **Vern Bremberg** is president of Unitas Corp. and vice-president of MVR Chemicals Corp. Vern is in the business of technology transfer and manufacture of fine chemicals. His son, Andrew, is 3 and a half, daughter Maria is 22 months old, and a new addition to the familiy is due in November. . . . **Michael Chessman** is living with his wife Mary, and daughters Rachel (12), and Laura (5), near Stanford, in Portola Valley, Calif. He is enjoying the sunshine, but misses the Cambridge life. Mike works at Dysan Corp. making magnetic disks for computer memories. He would welcome hearing from nearby friends or visitors to the Bay Area.

Brian Strong started a new company in 1979 with his wife, Nancy (Wellesley, '65). "Fitness, Inc.," now employs 130 part time instructors to provide aerobic exercise for over 10,000 people around the U.S. . . . **Steve Swerling** left Tektronix in June of '81 to become vice president of engineering at Mentor Graphics Corp. Mentor makes computer aided engineering workstations, and their first product was released this past summer. Steve was heavily involved in bringing Tektronix into the VI-A cooperative education program prior to his departure. . . . **Dave Johnson** recently moved to Connecticut to join Automation Machinery & Development Corp., owned by Richard S. White, '48. Dave will have responsibility for sales and marketing, and is understudying as chief executive officer. The company is located in Stamford, and the Johnsons are living in Guilford, Conn. Dave has sons 13 and 19, the latter a student at Auburn University, and daughters 5 and 16. The middle two are top students, the other two enjoy life, says Dave. Spouse Lyla finished in 1973 in nursing. Dave says that he and his family have lived in 24 places over the years, including Germany and five years in England.

A press release informs us that **Bob Vernon** was named manufacturing vice-president and will head the Wayne, Penn., manufacturing operation of the Americas Division of Sperry-Univac. . . . **Ron Englade** is running for the School Committee in Groton, Mass. (Actually the election was last April 5th, but all I have is a March 23rd news article about the upcoming election. Write and tell us how you did.) Well, that's a lot of news for this month. Keep those cards and letters coming in, and remember our 20th Reunion coming up next June. Put it on your calendar—let's have a record turnout.—**Mike Bertin**, Secretary, 18022 Gillman St., Irvine, CA 92715

64

Dear Classmates: The vicissitudes of life and work continue to drive my M.I.T. secretarial responsibilities to the "back burner," or, more appropriately, the bottom of my briefcase. I want you to know that some things actually get removed from my briefcase—it is the three-inch American Tourister type—but that *never* happens to M.I.T. Anyway, so here I am again, with three months' goings on of our classmates, er . . . at least that subset of our classmates that sends news or makes news.

W. R. Young, '64

William R. Young was recently named a member of the Board of Directors of Dean Witter Reynolds, Inc., among the largest securities firms in the United States. Young joined Dean Witter in 1980 as a senior vice-president and assistant director of research, and will retain these positions. In addition to his management assignment in the Research Department, he and his colleagues are responsible for analysis of the chemical industry and U.S.-based chemical companies. Young has been awarded First Place on the *Institutional Investor Magazine* All-Star Team for his coverage of the chemical industry in each of the past three years. Bill, his wife Linda, and their two children reside in Greenwich, Conn. And from those classmates who send notes with their contributions, we have the following . . .

Jim Allen has established American Conservation Co., Bethesda, Md. They do geothermal heat applications for residential and commercial customers. . . . Now in his 18th year with Dorr-Oliver, **Peter Angevine** also is continuing his hobby of working actively in the Credit Union between business trips. This May the Angevine family planned on traveling to Bombay, India. . . . **Richard G. Cease** has been named a consulting engineer of Raytheon Co., a manufacturer of electronic items and appliances. . . . **John B. Eulenberg** is director of the Artificial Language Laboratory and associate professor of computer science, linguistics and African studies at Michigan State University in East Lansing. He is currently working on wheelchair-portable talking computers for non-speaking persons. His wife, Marcia, is a freelance editor. The Eulenbergs have two children, Alexander (12) and Rachel (7). . . . The new president of Solar Turbines, Inc., is **John Hanson**. Solar Turbines is a subsidiary of Caterpillar Tractor.

Joseph F. Kasper, Jr., is now director of SLBM Programs at TASC in Reading, Mass. Joe is continuing to serve as an M.I.T. Educational Council member working with three high schools in the Merrimack Valley. The Kasper family did "all the canyons" in the U.S. Southwest on their most recent vacation. Their daughters are now 9 and 11, sort of "pseudo-teenagers." Joe's wife, Pat, is teaching art at a junior high school in Andover. . . . Another alumnus working for TASC in Reading, Mass., is **Gordon P. Nelson**, though much of his time is spent working in Washington, D.C., leaving him little time to play with his new home computer.

Cliff Laurence is a staff research scientist for the Energy Laboratory at the University of Houston. Cliff specializes in the optical design and performance of large scale solar-thermal energy systems. . . . Ever since graduating from the 'Tute, **David Plumer** has worked as a "traveling lecturer/goodwill ambassador" for Digital Equipment Corp. David is currently residing in San Francisco, representing DEC's central engineering within its Western Region. . . . **Charles Therrien** is on leave of absence from Lincoln Lab and is spending a year teaching at the Naval Postgraduate School in Monterey, Calif. (secretary's note: tough duty!).

Don Topkis is in the Operations Research Department of Bell Laboratories, in Holmdel, N.J. He is also an adjunct professor in the Department of Industrial Engineering and Operations Research at Columbia University. . . . **Robert Weinberg** is now professor in the M.I.T. Biology Department. He and wife Amy are living in Brookline with their 1 and 3 year olds. . . . **Lawrence Seligman** has left Data General Corp. in Westboro, Mass., for parts unknown. Larry, let's hear from you! . . . **Jay Tenenbaum** has helped to start a major new industrial artificial intelligence lab at Fairchild Semiconductor in Palo Alto. Jay directs research in computer perception of images and speech.

The Hanaseco Insurance Co. of Boston, Mass., a John Hancock subsidiary, has named **Stephen F. Kraysler** a senior vice-president. . . . **Julian R. Adams** reports he is having a successful year as a Chrysler-Plymouth dealer in Lynchburg, Va. In addition to being the number five ranked squash player in the state for 1981-82, his other hobbies are raising Bonsai trees, vegetable gardening, and banjo picking. Julian is married and has three children. . . . **John E. Carlin** advises us that he is remarried, has a baby daughter and a 10-year old stepdaughter, and is really enjoying family life. . . . **Robert L. Fischer** is now chief, Theater Affairs Division, Strategic Programs, U.S. Arms Control and Disarmament Agency. He is also a member of the U.S. Delegation to the Negotiations on Intermediate-Range Nuclear Forces.

Leslie (Bud) Boring has written to say all is well with his family. Eighteen month old Anne-Leslie is now up, walking and getting into everything. The Borings enjoyed a super visit from Barbara and **Mike Monsler** last August when Mike presented a paper at a nuclear physics conference in Paris. Bud's most recent activity has been successful entry into the salon circuit around Paris with the acceptance of one of his paintings by the Salon d'Autourne at the Grand Palais last November. He also won the Prix de la Ville de Croissy sur Seine, the first medal ever awarded by the Art Association in their town in its Salon. Bud loves living in the Paris suburbs, within 20 minutes walk of scenes actually painted by the impressionists!

Here we are in July (in case you didn't know how far in advance the October issue is written), the kids have been at camp 12 days now (and I *really* miss them), and we're trying to schedule the remainder of the summer. One of the stops along the way will be a trip to Mass. (Weston to be precise) to help **Gary Walpert** celebrate his fortieth. Gary's *much* older than I am (at least six or eight days' worth). There will also be one or more trips to Maine to visit the kids, vacation, etc. And probably a trip to California, though I'm doing less of that lately. And, finally, I may *have* to make a business trip to Hyannisport later this month. The person who works for me who would normally have made the trip is on leave that week, and I have to pinch hit. I have been razzed interminably about having such tough assignments. Meanwhile, Marlene has begun a career as a travel agent and positively loves it. Stay well! Enjoy Halloween! Write!—**Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, MD 20954

65

By missing the deadline for the last column, I at least assured us a respectable (though modest) column for October. It must be the year-end rush of Alumni Fund envelopes. **Walter Miller** is living in San Francisco and is a physician and researcher in pediatric endocrinology on the faculty of the University of California. Walt reports that he received the 1982 Ross Research Award from the Western Society for Pediatric Research for his work cloning genes for bovine growth hormone and prolactin, and for his studies on the structure and processing of the precursor to human ACTH. However, he says that the studies take time from his wine-making and will have to be curtailed in the future. . . . Carol and **Ralph Cicerone** have one child, a daughter Sara (8). Ralph is director of the Atmospheric Chemistry and Aeronomy Division at the National Center for Atmospheric Research in Boulder. . . . **Cal Cordulack** reports that he is alive and well, and is working in marketing management for IBM. The Cordulacks live in Stamford, Conn., and enjoy skiing and sailing.

George Lee reports that after 13 years at TRW he is now a self-employed author of consumer computer software—working at home, no commuting, just computing. He says it's really a very rational way to live if there were only any money in it. . . . **Barry Yudell** says that since graduation he has replaced his pool playing with skiing and driving sports cars. Barry says he is (also) in computers but would rather mention the skiing and sports cars. . . . **Les Schmerr** was promoted about two years ago to professor of engineering science and mechanics at Iowa State. Les's wife, Mary Joe, is a research chemist at the National Animal Disease Laboratory in Ames, Iowa. Their family consists of a daughter and two sons, aged 2, 3 and 4 respectively. Their home is a 40-acre farm about 30 miles from Ames. They enjoy the rural life but not the long drive to work in the severe winter. . . . **Yazan Sharif** has been promoted to manager of new product diversification at Dresser Industries' Corporate Headquarters in Dallas. Yazan wrote that his wife Linda and children Yasameen and Sayf planned to join him at the end of the school year. He was busy house-hunting in Dallas.

Scott Blouin says he has been extremely busy and letters are en route to all he owes them to. Scott and Susan have two children, Eric (13) and Rebecca (10). Scott is now vice-president of Applied Research Associates, Inc., an Albuquerque-based research firm. Scott runs the New England Division based in metropolitan South Royalton, Vt. He says it's a great place to work but that they don't get a lot of off-the-street business. Scott says that among their more interesting projects is the design, construction, and monitoring of a "super-efficient" house. He says the prototype, a 4-bedroom 1750s style colonial with 1800 square feet of floor space, required only $86 worth of electric heat for the entire winter of '81–'82 in tropical South Royalton.

Ron Newbower is acting director and associate director for research activities of the new Department of Biomedical Engineering at Massachusetts General Hospital. . . . **Jim Stuhmiller** is vice-president of the JAYCOR Fluid Dynamics Group in southern California. . . . Another Californian, **Dean Athans**, is chairman of the Engineering Department of East Los Angeles College. . . . **Mike Edesess** is manager of energy research and development marketing for Flow Research Co. in Denver. . . . **Pat Winston**, who has been widely cited in recent years for his research, teaching, and book on artificial intelligence, has been promoted to full professor in the Department of Electrical Engineering and Computer Science at M.I.T. Pat has also been director of the Artificial Intelligence Laboratory since 1975.

So that's October. Now off to Woods Hole for a summer study on computer security—it's really early July, you see, and this column is brought to you through a time warp by—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

66

After an incredibly wet spring, summer finally arrived and some of us made the most of it. Eileen and **Walt Shedd** and Theresa and **Joe Shaffery** were participants in a 60 person all weekend bash in the Hamptons. A great time was had by all. . . . **Eleanor Klepser**, our former class secretary, has started a part time job as a programmer for a new company in Eldred, Penn. She is looking forward to getting back into the technical world. . . . **Jim Sweeny** has recently been appointed chairman of Stanford University Institute for Energy Studies. . . . **James Lanyk** is working for Drilling Mud, Inc., in Casper, Wyo.

I received two pieces of very sad news this month. **Karen Henry Atwood** passed away at her home in East Sandwich, Mass., after an illness of three years. She leaves behind her husband Jacob, and two children. **Paul Rudovsky** then informed me that he had learned of the passing of **Warren Gladstone** in an auto accident in November 1981. He left behind his wife Sue and two children.—**Joe Shaffery**, Secretary, 34 Hastings Dr., Fort Salonga, NY 11768

67

Our 15th Reunion in June was a resounding, well organized success—thanks primarily to **John Rudy**. Approximately 70 class members participated, with total attendance at approximately 115 for the Friday dance and more than 150 for the Saturday picnic. Although an all-time Boston rainfall record for the month of June was set by mid-month, we did have reasonably decent weather for the reunion. Special recognition goes to the seven women in our class, representing 20 percent of our "better half," who attended. More news about them will be provided next month with news about other attendees to follow. The quickest and least democratic election ever resulted in the following (I believe): **Jeff Weisen**, president; **Gary Garmon**, vice president; **John Ross**, treasurer; **John Rudy**, class agent; **Jim Swanson**, secretary. The reunion was the first I have had the opportunity to attend, and frankly, I enjoyed it even more than anticipated. Other first-timers had a similar reaction. Plan on attending our 20th Reunion—it will be worth the time and effort.

Laurie and **Richard Feiertag** proudly announce the birth of Jonathan David on May 4th. Richard is director of research at Sytek, Inc., a Sunnyvale, Calif. company producing local area networks. Laurie is engineering publications manager at Convergent Technology, a computer systems manufacturer in Santa Clara. . . . **Ted Tenny** writes that he received his Ph.D. in mathematics and computer science at Clarkson College in May and has accepted a faculty position in electrical engineering and computer science at the University of Oklahoma. Since Ted grew up in Oklahoma, his return "to O.U. will be just like old times." Ted and his wife Jacque have two girls, Trixie (5) and Clara Jane (2). . . . Carol and **Steve Alter** are busy with their first child, Emily Ruth, born April 28th. Carol is a pediatrician, and Steve is vice-president of a computer software company. . . . Since 1980 **Yupo Chan** has been an associate professor at the State University of New York at Stonybrook. He previously had a Congressional Fellowship in the Office of Technology Assessment. . . . **Dana Ballard** is co-author of the first fully comprehensive survey of current research regarding the making of machines that see. The book, *Computer Vision*, was recently published by Prentice-Hall.

Please take a few minutes to write me a short note about your activities and please remember that there is a delay of at least three months between the time I receive information and the date of publication.—**Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

68 15th Reunion

Our Class Hero of the Month award is granted jointly to two classmates—**Dennis Sager** and **Stephen Wilson**. Dennis telephoned us recently from nearby Reston, Va., to offer his assistance in planning our 15th Reunion. (Yes, believe it or not, time is flying and our next reunion is just around the corner!) He also updated us on his recent acctivities. After a stint at MITRE in the mid-seventies doing air traffic control work, Dennis opted for the medical field. He enrolled in Eastern Virginia Medical School in Norfolk, and after completing that, did residency in Dayton, Ohio. He has been in private practice in internal medicine since last October. He has three children: two girls, and a boy born February 17. . . . Stephen got his Ph.D. from M.I.T. in mathematics in 1972, then spent six years at Princeton, came to Johns Hopkins University in 1978, and was promoted to full professor in 1980. He has taken leave in 1974-75, 1977-78, and most recently in 1980-81 to visit Japan, China, India and Israel. He also visited Portugal in the spring of this year. He is already planning his next leave for 1983-84. He enjoys Baltimore and the area when he is there, and anyone's welcome, as they have six bedrooms only three blocks from campus.

Henry Dixon writes that he and his wife Peggy have two girls, Elizabeth (5) and K.C. (3), and have been living in Connecticut for the past seven years. After leaving M.I.T., he worked for NAVSEA for three years, then went to USC, where he earned a B.F.A. in 1973. He then worked for Deutsch Company for eight years. He most recently joined Sierracin Corp. of California as the eastern marketing manager for their aerospace divisions. He reports having seen **Dan Nichols** at the Navy Department in Washington, D.C., last year, and he also reports that his brother-in-law is Bill Cimino, '80. . . . **Barry Mitnick** reports that his twins, Jenny and Jeffrey, were born in August 1980, five weeks early, while he was at the American Political Science Association meeting in Washington. "The twins are great," he reports, "but there are diseconomies of scale." His book, *The Political Economy of Regulation: Creating, Designing, and Removing Regulatory Forms*, was published in 1980. Finally, he has been promoted to associate professor in the Graduate School of Business at the University of Pittsburgh.

Ron Rosen reports that in addition to keeping busy with his own custom software development business, he is still working part time with Marist College, now in the position of academic computer use coordinator. He recently put on a series of faculty staff workshops in computer use. . . . **Erich Schuetz** writes that he is now division manager with Cooper Laboratories in Palo Alto, Calif., manufacturing and distributing argon and CO_2 lasers and diagnostic and therapeutic ultrasound. At last writing, Even Kristof (3) was the "joy of their lives," and another addi-

tion to the family was expected in June. . . . **Steve Kanter** is professor of law and acting dean, Lewis and Clark Law School in Portland, Ore. He recently appeared as amicus curiae before the Oregon Supreme Court for the Oregon ACLU, arguing successfully that the state death penalty statute was unconstitutional.

Reynold Martin recently joined General Foods Operations Engineering Group based in Dover, Del. . . . **Rick Rudy** is currently quality assurance manager for laser products at Spectra-Physics, Inc. Recently, he served as vocal director for a local production of *Most Happy Fella* and played the lead role in Neil Simon's *The Good Doctor*. Finally, he has been treasurer of the M.I.T. Club of Northern California. . . . **William Hutchison** is still selling mini- and microcomputers in the Delaware Valley area.

A final group of items we have to report comes from press releases. **Fredda Cole** has been named vice-president, product design, at Data Architects, Inc., Waltham, Mass. . . . **Jeffrey Tranen** has been named manager of Massachusetts Electric Company's Palmer office, responsible for the electric operations for 16 towns. He had been with the company since 1970 and has held positions previously as engineer and as staff assistant to a senior vice-president of the parent company, New England Electric. . . . **Michael Yokell** is chief administrative officer for Energy and Resource Consultants, Inc., in Boulder, Colo. . . . **Charles Meyer** has been appointed director of marketing for European classroom operations for Weight Watchers International. He will direct classroom marketing programs in 12 European countries from a London office. . . . **Richard Boyatzis** has been appointed to the personnel board in Sharon. He is president of McBer and Company, a Boston management and reseach consulting firm, and the author of a recent book on management consulting, *The Competent Manager*.

Our own news is that **Gail** has been elected to a three-year term on the Board of Directors of the American Nuclear Society, a 12,000 member international technical organization of professionals in nuclear-related fields. We are still seeking volunteers to help with reunion planning, and more news items are always welcome.—**Gail** and **Mike Marcus**, Secretaries, 8026 Cypress Grove Lane, Cabin John, MD 20818

69

Once again an off-year reunion of the class of '69, our 13th, was cordially hosted by Sina and **Tom Najarian** at their home on the beach in Hull. Despite gloomy forecasts, the weather remained dry, if not always sunny, and we had a record turnout.

For those who have thrown the "N" page of their address book away because of too many changes, **Bruce Nappi** is now in Reading, Mass., trying to settle down with his wife and two daughters, ages 6 and 8. Bruce has recently started work with United Electric as director of engineering. . . . Lanye and **Jeff Lepes** still reside in Needham, Mass., with their two children. Jeff is a vice-president at Marshall Paper Tube Co. in Randolph, which has doubled its capacity recently and eagerly awaits the promised economic recovery. Lanye, on crutches because of some torn muscles, expects to be back in condition and running in a six-mile Bonnie Bell road race in October. . . . **Bruce Anderson** married Deborah Napior in May, and together they continue to publish *Solar Age* magazine. Bruce is also president of TEA, Inc., an energy design and consulting firm based in Harrisville, N.H.

Arlene and **Ray Smith** are expecting a new arrival in the family in November. Their daughters, Jennifer and Leanne, recently starred in local productions by The Magic Finger in Arlington, while Ray continues his work at Genrad. . . . Beth and **Bob McGregor** recently went to the wedding reception of Nancy and **Greg Dieguez** at the Boston Museum of Transportation. The marriage took place a week earlier at the top of Mt. Washington in N.H. The McGregors' second daughter, Madeleine, was born July 8, and Bob and Beth are now getting ready to take a year off and enjoy life. . . . Pat and **Don Uhl** reside in Bloomfield, Conn., where Don is at Combustion Engineering in Windsor doing thermal hydrolic design of nuclear reactors. Pat is a registered physical therapist at St. Francis Hospital and Medical Center in Hartford.

In July 1981 **Irene Greif** married Albert R. Meyer, a professor in M.I.T.'s Department of Electrical Engineering and Computer Science. Irene is continuing research in office automation as a principal research associate in the M.I.T. Laboratory for Computer Science. . . . **Carol Scott-Conner** has just completed her first year as assistant professor of surgery at Marshall University School of Medicine, a new medical school in West Virginia. Carol is doing general surgery, mainly gastrointestinal, and reports that she and Harry have fallen in love with West Virginia and are very happy.

Thus ends another edition of class notes. Remember, if you don't let me know what you've been up to, it's hard to let the rest of the class keep in touch.—**Robert K. Wiener,** Box 27, M.I.T. Branch, Cambridge, MA 02139

70

Sydney V. Jackson is now a systems analyst for Energy Technologies Group at the Los Alamos National Laboratory. His work includes risk analysis for energy technologies. . . . **Ronald Abramson** is involved in computer law at Fenwick, Stone, Davis & West in New York City. . . . **Timothy D. Lunden** is director of software engineering for Davony Systems, Inc., with products in the personal computer hardware market. . . . **Wesley Moore** attended the AAAS meeting in Washington, D.C., in January. He talked to **David Hall** about his post-doctoral work at Albert Einstein in New York City and to **Harold Federow**, who now lives in Seattle.

Alejandro Chu is at Lincoln Lab and is presently involved in the development of GaAs devices and monolithic circuits for MM-wave transceivers. Prior to that he worked at Hewlett-Packard Co. . . . **Robert Collesidis** has been named vice-president of engineering at Signal Processing Systems in Waltham, Mass. He has been with Signal for ten years and is responsible for all engineering activities at the company.—**Robert Owen Vegeler**, Kennerk, Dumas, Burke, Backs, Salin and Vegeler, 2120 Ft. Wayne National Bank Bldg., Fort Wayne, IN 46802

R. Collesidis, '70

71

H. Dubose Montgomery completed his term as chairman of the M.I.T. Alumni Activities Board and as a member of the M.I.T. National Selection Committee. Next year he will be a member of the Corporation Development Committee and of the Alumni Fund Board. . . . **Chris Brewster** is getting married. More on this later. . . . **Jerry** and **Sandi Croan** have been in Fairfax, Va., with their two children for four years. Jerry is vice-president of the Human Services Division of SRA Corp. Sandi dabbles in and out of physical therapy and is now involved with community theatre and the rescue squad of a local fire department. They are anxious to hear from AEPi alumni. . . . **Kenneth R. Vogel** has moved to Los Angeles to start teaching law, with an emphasis on economic methodology, at Loyola Law School. He has been appointed to the editorial board of Law and Policy Quarterly. . . . **John L. Kulp, Jr.** is vice-president of research and development for Symbolics, Inc. . . . **Alvin W. Lippitt** is with the Event Analysis Department of the Institute of Nuclear Power Operations in Atlanta. His wife, Jean, has opened her own pediatric office in Marietta, Ga. Their daughter, Florence, is growing like a weed.

John Davidson has started his own firm, Davidson/Yuen Partners, and wonders why he waited so long. He has a good flow of residential, commercial and institutional projects, especially for non-profit community groups and native Indian bands. . . . **Arpad J.M. Lamell** is in advertising and public relations at Lamell Advertising. He also has a number of smaller investment projects underway. . . . **Ah-Poh Yao** writes: "I arrived in Victoria, B.C. last month. There's a great fishing ground here. This is God's country. I had been in Edmonton and Toronto and will be in Calgary on job interviews. My job experience in the hydrocarbon processing and marketing industry coupled with an excellent education opportunity at M.I.T. sure opens a lot of doors for interviews."

A. Nihat Berker has been promoted to associate professor at M.I.T. His main area of interest is statistical mechanics and the theory of first and second order phase transitions where he has used renormalization group methods. In addition to his B.S. in physics and chemistry from M.I.T., he holds an M.S. and Ph.D. in physics from the University of Illinois at Urbana-Champaign. He joined the faculty in 1979. Please let your classmates know what you are doing.—**Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

73 10th Reunion

Mornin! I received a fair amount of mail since last column, possibly a result of lots of people writing. **Ira Gershkoff** mentions that after three years in Boston with Dynamics Associates, an M.I.T.er-bred software firm, he moved to Washington for five years in aviation engineering with FAA. Ira married Pamela Cass in 1979 and now they have a 2-year-old named Amy ('02). She will learn bridge, Ira asserts, as soon as she loses her taste for peekaboo. Last May Ira began work for American Airlines in DFW in Operations Research. The best, he says, is for last, as he and Richard Trachtman ('74) have written a book called *The Boston Drivers' Handbook*, a sarcastic tome on survival as a Beantown motorist. Look for it at "your neighborhood Paperback Booksmith equivalent," quoth he.

Glenn Sharfin has finally finished his residency and will be practicing orthopedics in sunny Plantation, Fla. Phyllis and two daughters are looking forward to the new lifestyle. . . . **Peter Messinger** completed a tour with the Peace Corps in 1975, has been a teacher at the ALA at Northfield-Mt. Hermon, and a director of the American Language Academy in Vermont, a post he holds today. He was married in 1980, is a father to be, and has a knack for abbreviation that I hope will make him forgive any possible chronological inaccuracies.

James Reuss received his Ph.D. in biomedical engineering at Northwestern; he is currently engaged in medical pattern recognition at Medicomp, Inc., of Melbourne, Fla. . . . **James Weihe** is a forensic psychiatrist in San Francisco. . . . **Jeff Seltzer** calligraphs a note to say he cannot break away from Boston; he will do another year of a cardiology fellowship at BU in pacemaker research. . . . **Ann McBain Ezzell** was Womens' epée champion of the Northern Ohio division, and second in foil. Ann competed in the Midwest sectionals in Wisconsin, and will come down to the real God's country to vie in the nationals at George Mason University in Fairfax, Va. . . . And old (aging?) **Doug Luther** was appointed assistant research oceanographer at Scripps, after completing his last cruise on the Green and Colorado rivers. He found, of course, that 80 horsepower outboards get poor gas mileage.

Barton Adrian and spouse are enjoying life in Idaho very much. Work is picking up and spare time is spent with Benajmin ('05). He would like to salute old BTB's and invite them to Sun Valley next winter to

ski. Spuds on the house. . . . **Joanne Carignan** has been appointed senior instructor in oncology at the University of Rochester School of Medicine. . . . Ruth and I, having packed the kids off the Gramps 'n' Granny's for the summer, are on our way away, first to Wooster, Ohio, to meet the **Tony Scandoras** at our annual jaunt to the Ohio Light Opera's summer weekends of Gilbert and Sullivan ("... can't get enough of that G & S ..."), then to Dallas for the Mary Kay seminar. Should be a jolly summer.—**Robert M.O. Sutton, Sr.**, Secretary, 819 Buckingham Ct., Warrenton, VA 22186

74

Good evening, and now to the news. In our top story tonight, **Rod Taft** married Chris Thebèrge in May. In a whirlwind courtship, Rod debated an entire eight days before popping the Big Question. As Chris says: "When it's right, you know it." . . . Received a lovely little card (with no return address on it) signed "Beth, **Ken Green**, and Aaron." Assuming Aaron's not the dog, that means they've had a baby. The postmark was Houston, and that's all the info I have. . . . The average sneeze has been clocked at 200 miles per hour. . . . **Meryl Nass** wrote a whole letter summarizing the events of the last few years. She's been married to John Abernethy five years now. John is a great-nephew of Richard Cockburn Maclaurin. They're living in Jackson, Miss., where he's a researcher at the University of Mississippi Medical School. Meryl finished med school and promptly had two boys, Abraham and Jacob, in rapid succession. She, by now, will have started her residency. Mississippi is quiet and a good place to be a doctor. . . . The adhesive on the back of a postage stamp contains one-tenth of a calorie. . . . **Arthur C.Y. Lee** writes that he's controlling hardware modifications to our worldwide satellite telemetry, tracking, and control network. He is stationed at Sunnyvale Air Force Station. As he says: "It's intense!" . . . Which reminds me of the cartoon where a lab technician peeks his head up to see world-wide rubble and moans "It was only a *little* bug!" . . . **Elizabeth Wise** and husband **Robert (Jock) Young** are enjoying life in the wilds of Washington state. She has a family practice with two other M.D.s, and 10-month-old Jonathan stays home with dad.

Frank Morgan is undergraduate mathematics chairman at M.I.T. He will be spending next year at Rice University. . . . The words "race car" are the only two words in the English language that spell the same thing forward and backward. . . . The world has not tamed **Charlie Bruno**. He now works for the Sohio Construction Co. in Prudhoe Bay, Alaska, at the north end of the Trans-Alaska Pipeline. To quote his interesting note: "I have established an engineering firm and a high-performance automotive construction/repair shop. I am an avid runner, parachutist, skin and scuba diver and car freak. Still single." . . . Winston Churchill smoked an estimated 300,000 cigars during his lifetime. . . . **Paul Mailman** left DEC after four and a half years to join Atex in Bedford, Mass. Paul is an instructional design specialist. . . . After graduating from Harvard Law in '77, **Marc Lauritsen** began patiently providing free legal representation to indigents through the Worcester-based Central Massachusetts Legal Services organization. He is also working half-time as an instructor at Harvard Law School, lives in Hudson, Mass., with wife Joy Bahniuk, three dogs, two cats, and three horses. Marc enjoys jazz piano, cooking, and working in the garden. . . . It takes 72 muscles to speak one word. . . . **Jerry Horton** writes that after working at the U.S. Department of Transportation and the M.I.T. Industrial Liason Office, he's back at the chemical engineering department for his Ph.D.

Gary Raymond finished his M.B.A. at the University of Chicago late in 1981 and is now applying his education to keep his company going. He doesn't say which company it is, but in this troubled time, aren't we all doing just the same thing? . . . Nobody ever wrote a biography of Chester A. Arthur, 21st president of the United States. . . . **David Humsey** writes to say that he and recent bride Caroline Kent are now impoverished homeowners. David has his own big-bank management consulting firm based in Cambridge. . . . **Marty Davidoff** also recently announced the establishment of his own accounting practice, specializing in taxes and real estate. . . . More than four tons of aspirin are consumed daily in the United States. . . . Sue and **Steve Jordan** announce the birth in early May of their first, Elizabeth Brooks. . . . **Michael Hassett** has joined Englehard Industries in Edison, N.J., as an attorney in the legal department, specializing in commercial law and antitrust compliance. He and Ilene live in Woodbridge.

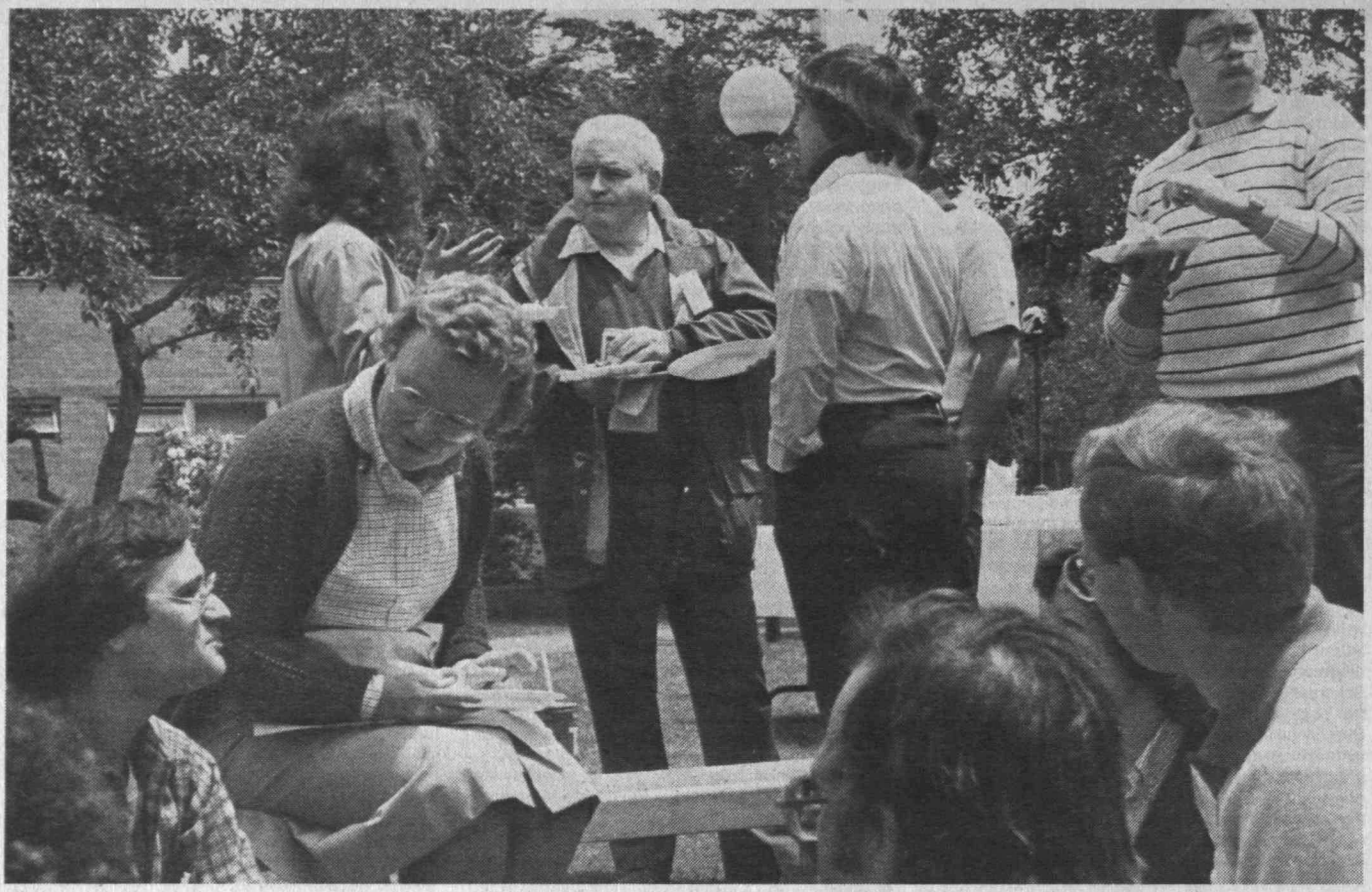
Anne Bossi received her Chartered Life Underwriter (CLU) certification in 1979 and was recently elected vice-president, computer systems, for the Prudential Insurance Co.'s Systems and Services Office in Roseland, N.J. Anne lives in Flanders. . . . It took Handel only 21 days to write the *Messiah*. He did it because he needed the money. . . . **Charles Merrill** has been promoted to senior programmer for John Hancock Mutual Life Insurance Co. in Boston. . . . **Jae S. Lim** was recently elected to level of associate professor in the electrical engineering and computer science department at M.I.T. Jae lives in Winchester, and received his S.B., S.M., E.E., and Ph.D. all from dear old Tech. Shows you where that sort of thing can lead. . . . Many, many thanks to three members of our class who contributed $250 or more to the Alumni Fund and became Great Dome Associates: **Michiro Iwanaga**, **Mary A. (Bradford) McCarthy**, and **Gary David Raymond** (see above). . . . And in one final blast of trivia, penguins will crowd up to the edge of the ice and push until one of their number falls in. If he comes back to the surface, they all know there are no sharks in the water and the rest will dive in. If he doesn't surface, you'll have to write me to find out what happens.—Co-Secretaries: **Lionel Goulet** 34 Tremlett Square, Dorchester, MA 02124 and **James Gokhale**, 6 Pond Lane, Arlington, MA 02174

76

Jerry Dausman has sent word that he is "now married and just back from a Venezuelan honeymoon." . . . **Jules Morris** is working as a patent attorney for Hamilton, Brook, Smith, and Reynolds in Lexington, Mass. He still resides in Brookline. . . . **Jan Taniguchi** is an architect with Skidmore, Owings, and Merril of Chicago. . . . **Richard McAdoo** is keeping busy by working overtime as an engineer on the River Bend nuclear plant near Baton Rouge. He says, "After paying my taxes, my happily libertine nature is stronger than ever. I wish Uncle Sam would get the message, but . . . Plans for the summer include attending my high school reunion, buying a computer, vacationing in England and Scotland, and whatever else I can find time for." . . . And from **Sue Litvin**, "I have been in London for the past two years working with American Express as director of planning and analysis for Europe, the Middle East, and Africa. I travel frequently and I always try to look up other M.I.T. alumni in Europe. I have found many old friends and some new ones in the Paris M.I.T. Club, and I am now part of a team that is revitalizing the London M.I.T. Club. If there is anyone in the U.K. who is interested in participating in the M.I.T. Club, please ring me up at the American Express Card Division in Brighton, England." . . . **Dianne Glennon** is "currently working as a sales engineer for Boston Edison, and can be seen working out regularly at the M.I.T. athletic facilities or performing as a professional Middle Eastern dancer at local Middle Eastern or Greek supper clubs and private functions." . . . And from **Courtney McCracken**: "My wife Lynn and I and our two sons, Ryan and Eamon, are currently residing in Norton, Mass., while I pursue a master's degree in construction management at M.I.T. My next duty station with the Navy Civil Engineering Corps may be in the San Francisco area."

Javier R. Pique del Pozo has sent us the following: "Since my return to Peru in 1977, I rejoined the faculty of Universidad Nacional de Ingenieria in Lima, on a part-time basis as an associate professor of the graduate school. In 1979 joined the Junta del Acuerdo de Cartagena (JUNAC) which is the technical administrator of the five member countries of the 'Andean Pact' (Bolivia, Colombia, Ecuador, Peru, Venezuela), to work on a research project to develop technical information for designing with timber from our tropical forests. I am editing a handbook for design to be published at the end of 1981 by JUNAC." . . . **Erland van Lidth de Jeude**'s latest is a horror film, *Alone in the Dark*. Also, since the last notes, he did 16 episodes of the television soap opera, *As the World Turns*. Your secretary will try to catch the horror film, when released. Erland, judging by the pre-release notices, has a frightening role. . . . From **David Stork**: "I'm working hard to finish my Ph.D. in physics at the University of Maryland before I join the faculty at Swarthmore College in Pennsylvania. My first book has already gone into its second printing ('a healthy start' says my editor) and my second book, *Seeing the Light: Optics in Nature, Photography, Holography, Vision, and Color* (Harper and Row) goes into production soon." . . . We have a lengthy letter from **Jim** and **Barb** (née **Slocum**) **Miller** from which I unfortunately have to abstract. ". . . We are finishing up our year long adventure in Alaska. We left Boston on July 10, 1981, and drove across the continent via the National Parks for about eight weeks. We met a lot of old M.I.T. friends on the way: Joanna Hoffman, Dan Halbert, and Jack Lissaeur, '78, in the Bay area of California, Barak Gale (also '78) and **Kathy Dawson** in Seattle. We arrived in Seattle, hopped on the ferry (along with the car), and three days later we were finally in Alaska. We drove another 14 hours to Fairbanks, arriving around 10 p.m., August 31, just in time for the sun to set and leave us wandering around campus in the dark trying to find someone who could tell us where we were supposed to be living. After settling in, Barb found a job downtown as a programmer working for a small company called Systronics. Meanwhile, Jim started to work on his masters degree in engineering management. Shortly after our arrival (in mid-September), we had our first dusting of snow, and by the end of October we had about six inches that had no intention of leaving us until the end of winter. The daylight grew less and less, and we spent more and more time watching spectacular sunrises and sunsets. With winter well established, we dug into a routine. We get up well before sunrise, go to work or class, come home well after sunset, and then head to a rehearsal for the local musical, *The Pirates of Penzance*. Barb was in the chorus, and I ran errands and finally wound up running the lights. It kept us busy and prevented the onset of a serious case of cabin fever, a great problem up here. After rehearsal ended, we would occassionally watch the Aurora Borealis. They were quite magnificent at times. The snow finally departed in mid-May, and by the time we took our vacation over Memorial Day the snow was only lingering in shady spots and in the mountains. As summer arrived in early June (not much spring or fall), the sunlight got out of control. On the summer solstice (June 21), we had 21 hours, 48 minutes of daylight. The remaining two hours, 12 minutes were spent in twilight. Jim passed his comprehensive and will receive his degree at the end of August. He has accepted a job at the M.I.T. Artificial Intelligence (AI) Lab, thus bringing to an end a 10-year stay at Bolt, Beranek and Newman. He will start work September 1. Barb will be rejoining her old company, Atex, which had been purchased by Kodak while we were away." Your secretary is sorry he could not reproduce this letter in full.

And as for your secretary, he has been on the move, both physically and trading. Physically, these notes are being written in Geneva, Switzerland. A week of work there and a weekend to play in Brussels. Next, fishing in the Caribbean and a seminar in Boca Raton and West Palm Beach. And as for trading, obviously, Swiss francs. But also, gold, T-bonds, T-Bills, D-marks, and that perennial favorite, pork bellies. Life has not slowed down, either in the commodity pits or at Merrill Lynch. Instead, we bears have been dining rather well—on the carcass of the "body politic." It is, I know, a grisly analogy, but, then again, what is happening in the credit and forex markets is grisly, too (especially if you are on the wrong side).—**Arthur J. Carp**, Secretary, 15 Jones St., Apt. 3D, New York, NY 10014, (212) 741-3023



President and Mrs. Gray picnic with the Class of 1977 on Saturday afternoon of reunion weekend. An unprecedented 70 percent of the class donated a total of $15,000 to M.I.T. for their 5th Reunion gift. (Photo: John Mattill)

77

We have the pleasure of announcing the election of a new class president, **Charles Shooshan**, following his successful organization and execution of our 5th Reunion. **Dave Dobos** has resigned as class president, after a commendable five-year term, to become a member of the executive committee. **Carol Catalano Martin** is now vice-president and class agent. Other members of the executive committee are: **Kevin Miller**, **Steven Bader**, and **Eric Lindstrom**. Your secretary protem is now secretary permanent, as well as (I didn't know the job included this) class treasurer. We hope to serve our class well.

Paul Fallon completed his graduate studies in architecture and project management at M.I.T. in June 1981. After travelling in Europe during the fall, Paul and his wife, Lisa Dobberteen, returned home to Oklahoma where Paul works in a three-person architectural firm designing housing for the handicapped. . . . Jacqueline and **James Torma** have moved from Kingsville to San Antonio, Tex. . . . **Michael Cady** has temporarily retracted his invitation to visit his cottage in N.H. He explains, "Imagine me, a senior project manager with a large construction firm, being behind on a lousy cottage renovation job!" Michael would especially like his dorm-mates to contact him in Melrose, Mass. . . . **Joel Weingarten**, '75 and '77, received his architecture degree at Berkeley in 1978 and his license in 1982. He has now opened an architecture practice, Artek, Inc., in Emeryville, Calif. . . . **Lester Nathan** has recently been promoted to regional project coordinator of Leviton Manufacturing, and is training to become a teacher of manufacturing resource planning in the Rhode Island division.

Ira Pollack is finishing his internship in Chicago, and (probably by the time you read this column) moving to neurology residency at NYU. Ira spends his free time juggling. He says, "I recently learned how to juggle pins. On to hatchets!" . . . **Esther Horwich** has now opened a law practice in Boston. . . . **Douglas Feinstein** is still working toward his Ph.D. in biology at Johns Hopkins, and spends his free time playing classical guitar in a quartet at the Peabody Conservatory of Music.

William Kaiser has just finished his first year at Harvard Business School. . . . **Harvey Kaufman** begins his residency in pathology at Beth Israel Hospital, Boston, in July 1982. . . . **Mary Shaeffer** married Harold Fogg in June 1982, in Cincinnati. This fall, Mary will leave Procter and Gamble to attend Harvard Business School. . . . **Mitchel Kling** is now doing his residency in psychiatry at the University of Pennsylvania in Philadelphia. Mitchel is also working to prevent nuclear war, as a member of Physicians for Social Responsibility. That's all the news for now. I'll try to print any news you send me—but you do have to send the news!—**Barbara Wilson Crane**, Secretary, 6431 Galway Dr., Colorado Springs, CO

78 5th Reunion

Now it's time for me to babble again about news from our scattered classmates. I reach into the jumbled pile of letters and notes from you all and I pull out a rather extraordinary letter from **Rich Ware**. The highlights follow. Rich is working for Milton Bradley doing state of the art speech synthesis for their consumer toys and games, and writing games for home computers. He's also teaching at Smith College as a half-time lecturer, and in his spare time he has joined in research efforts in Berkshire County concerning alternatives to corporate capitalism. He climbs the local Berkshire Mountains, plays the Appalachian dulcimer, kayaks on the Connecticut River, and does Elvish calligraphy. (Secretary's note: on alternate Thursday nights he sleeps.)

Rich also cleared up a misstatement that I put in my last column. **Sue Coppersmith** got married last December. (I believe that I wrote that she would be married next December.) Sue got married to Robert Blank, whom she met on her year of study in England. Robert, it turns out, is a good friend of Rich's from high school. . . . small world. . . . **Scott Berger** is working as a process research engineering at Rohm and Haas, just north of Philli. He has found a new use for the shirt he bought from my UMOC campaign—he's taken up spelunking. He also asks a common question—how to get M.I.T. to put him in the class of '78 when the 'Tute thinks he's in '77. Well, Scott, and the rest of you so situated, it takes a letter or phone call to the Alumni Records Office from you. A call from me will not suffice. So, all of you misclassified souls, drop the records office a line soon. As Scott put it, "I'd hate to go to the wrong reunions!"

Speaking of reunions, it's getting to be time to plan our 5th one. At this writing, we have begun to organize a reunion committee, and we can use all the help we can get. (That was a hint, just in case any of you missed it.) The chairperson of our reunion committee is the ever-energetic and cheerful **Karyn Altman**, and she's looking for classmates to volunteer in several capacities. First, we have the main committee, which will be based in Boston and will take care of central planning. Also, we'll have several regional committees, to help with the problems of organizing our scattered classmates. And, of course, we'll be looking for anyone willing to lend a hand for

an hour or a month. . . . whatever you can do. If you're interested (or just curious) please call Karyn (617-427-5857), **Jim Bidigare** (617-661-4186) or me (617-491-5313), or write to me at the address below. Also, anyone having any interesting ideas is encouraged to get involved or get in touch. While Karyn hasn't been busy looking for volunteers, she's been (seemingly) working three or four jobs. One big accomplishment this year was coaching a Bronze Medal junior volleyball team in the Eastern National Junior Olympics. Send her congratulations, along with your offer of help. . . . Speaking of volunteers, **Jerry Epstein** is working away at his Ph.D. in astrophysics at U.C. Berkeley. He writes, "I spent a total of seven weeks last summer in Palestine, Tex., at the National Scientific Balloon Facility. . . . and now I can eat chicken fried anything." . . . **Carrick Davidson**, another volunteer, has been very active in Dallas. He was the president of the Dallas Rowing Club, and is now trying to start a new rowing club. Last fall he was up in Boston to row in the Head of the Charles. He hopes to go to law school this fall. . . . **Scott C. Chase** moved to San Francisco right after graduation, and has been there ever since. He's now working for Bechtel as an architectural designer for a Saudi Arabian airport. Last June, Scott went on the highly acclaimed national tour of the San Francisco Gay Men's Chorus.

Alan Marcum has been thinking about volunteering to work on our reunion, when he hasn't been touring in Europe or cruising in the Caribbean. . . . **Kathleen Parker Carley** was the social coordinator for the recent 3rd East, East Campus reunion, and I know she'll want to be similarly involved in our class reunion. Kathleen is now at graduate school at Harvard's GSAS. . . . **Vince James** will be volunteering to do some organizing in Cincinatti for our reunion. He's been working for Proctor and Gamble since graduation and is now a programmer for Math and Information Services there. . . . And of course, **Milt Roye** will have time to help us out while he's finishing up his last year at Harvard B School.

A report from our secretary of the geology subclass, **Steve Richard**, has him finishing up his masters thesis at the University of Arizona this past June. Steve reports that **Bill Jefferson** finished his masters there and moved to Denver last February to work for an oil company there. Also, Steve says that **Pat Fennessy** is finishing up her masters in hydrology but probably will stay on for a Ph.D. under "terminal student status." Last, but never least, Steve tells us that **Judy Stein** finished up graduate work at Stanford, and is working for Gulf Oil as a Geologist in Texas.

Ach, another lawyer in our midst. **Scott Bernard** just graduated from Boalt Hall Law School at Berkeley. Another classmatae-lawyer, **Al Knauf**, who went to Michigan with me, has returned to his home town of Rochester, N.Y., to do litigation work with a large firm there. Al sent me a very nice boring post card of U.S. Route 81. . . . And yet another Michigan lawyer, **Mike Harlan**, said he'd be out of the navy in September and was going to start law school at the University of Michigan, Ann Arbor.

Some people volunteer, some just send me boring postcards for my collection. Some, like **John Blaisdell**, will be doing both. (John's postcard, the only one I've gotten in months, was of the intramural PE building at the University of Illinois) . . . One person who MUST volunteer is **Sue Hanson-Walton**, our chairperson's former alter ego. Sue writes that she is well adjusted to married life; she canoes on a lake not 200 yards from her home in suburban Virginia, teaches aerobic dance, and loves her job. Sue will volunteer . . . as will **Diane Curtis**, whom I ran into on the subway just the other day. Diane is a project manager for the company that makes the very popular software package "Visicalc III." She was very secrative about the product of which she is a manager. However, she did tell me that it would be a new consumer software package. By the time this is published, her company will have moved from Central Square out to Wellesley. . . . **Robin Newmark** is working on her Ph.D. in marine geophysics at the Lamont Doherty Geological Observatoory of Columbia University, in Palisades, N.Y. Shortly after she passed her orals, she took a seven-week research cruise in the Pacific near Costa Rica in search of the perfect tan. Heavy academic research. . . . **Paul Edelman** finished his Ph.D. in psychology and social relations at Harvard this June, and hopes to begin work as a consultant to worker/employee owned firms. Any of you interested in starting up, or converting to, a worker-owned establishment are encouraged to call Paul.

Todd Buikema has moved across Texas to Dallas, where he is working for Atlantic Richfield as a log analyst. . . . Out in California, **Laura Swire** just finished her M.S.M.E. at Berkeley and went out and (seemingly) bought a house wiith it. (Talk about marketable degrees!) Her new house is in Freemont, Calif., on the east side of San Francisco Bay. . . . Also out in the Bay area is my good friend **Rich Perlstein**. Rich writes that he is working as a designer in the architectural firm of Kaplan McLaughlin Diaz on the waterfront in San Fran. Their work consists mostly of renovations and additions to existing buildings. Rich says now that he's out of school he has been rediscovering the fine art of enjoying life. . . . **Beryl Morrison** writes: "I finished a masters degree in biology at the University of Utah in July, and since then have been working as a programmer and editor of a manual in the Computer Science Department at the University of Utah. I also have been secretary/treasurer of the North American Guild of Change Ringers since September 1981." As soon as her husband Don gets his masters in computer science they'll be moving back to New England. . . . **Michael Stahl** is attending a seminary in Denver, and will soon enter the Methodist ministry.

Computer romance. That's right, **Paul Alfille**, who just graduated from University of Illinois Medical School, met his fiance over a computer. He'll be getting married to Laurie Shapiro, who recently graduated from University of Connecticut Medical School. Paul will be an anesthesiology resident at Mass. General here in Beantown. . . . Another medical classmate, **Steve Stein** , just gradtated from University of Connecticut Medical School, and is starting his residency in emergency medicine. (Steve asked me to thank all the people whom he spoke to as an associate class agent for being so generous.) . . . While we're on physicians, there's **Gary G. Gammon** who just graduated from University of Vermont Medical School and is now interning in West Virginia. Next year, Gary will work for the U.S. Public Health Service, after which he will enter into a surgical residency. . . . Meanwhile, **Michael D. Ries** will be working on his surgical internship—he graduated from Dartmouth Medical School in June.

We're also piling up the Ph.D.s. Let's start with **Steve Piet**. After eight straight years at M.I.T., Steve now has a complete set—S.B., S.M. and Sc.D. He is a senior engineer in the fusion safety research program of EG&G Idaho in Idaho Falls. . . . By contrast, eight straight years at M.I.T. was not enough for **Paul Lagace**—he got his doctorate in seven, and is now an assistant professor in Course III (materials science, for those who don't remember). And he still (practically) runs the M.I.T. summer softball league. . . . **Bill Kath** finished his Ph.D. in applied math at Caltech and spent the last year as a National Science Foundation postdoc there. He'll be starting as an instructor there this fall. . . . Yet another "doctor" is **Bob Ledoux**, who got his doctorhood in nuclear physics at the 'Tute, and is now a postdoc there in the heavy-ion group. . . . And this month's last Ph.D. belongs to **Bob Granetz**. His thesis was on plasma physics and fusion research. When he wrote, he couldn't decide whether he'd spend this next year at Los Alamos or whether he'd stay at the 'Tute.

Well, I'm going to stop babblin' for now, after a word from your sponsor. I'm still a struggling young attorney practicing in Boston and living in Cambridge—on the Common. My most exciting case of the year involves video games and civil rights; I didn't think that video games had civil rights either. A lot of my energy is now going into planning a wedding—mine. Hopefully, it will all be over by the time this is published—a small tasteful event up in Hanover, N.H. Here's hoping that you had a happy, sunny and suntanned summer.—**David S. Browne**, Secretary, 50 Follen St., #104, Cambridge, MA 02138, (617) 491-5313

79

Hello again, fellow '79ers! It's time for our favorite time of the month—reading M.I.T.'s version of the *National Enquirer*! By the way,have you heard about Anthony Geary and . . . **Mark Schwartz** was commissioned a second lieutenant in the Air Force, married Sharon Simon (B.U. '79), and went to work at Draper Labs—and that was all within a month of graduation! In April 1980, Mark left Draper to go on active duty at Air Force Pilot Training in Columbus, Miss., and was awarded his pilot's wings on April 28, 1981. Since then, Mark spent a summer at Holloman AFB in New Mexico for additional jet training and ten months at Homestead AFB in Florida where he learned to fly the supersonic F-4 Phantom Jet Fighter. The Schwartzes are currently at Seymour Johnson AFB in Goldsboro, N.C., where Mark is flying the F-4. This Tech tool proved that he is capable of other things besides flying fighter jets: he assisted in the birth (and the conception, I imagine!) of all 7 lbs., 4 oz. of Matthew Jason Schwartz this past April 25 (that's my birthday, too!). When they're not piloting jets and birthing babies, Mark and Sharon get together with Cathy and **Dan Jaime** in Ft. Bragg, or talk with Mark's old Baker house roomie **Mark Stern**, who is now in his second year at Harvard Business School. Thanks for writing, Mark!

Scott Holmes writes, "Married a local girl in January. Jean teaches multiply-handicapped students at a vocational high school for the handicapped here in Dayton. Meanwhile, the Air Force has me setting up high power generator tests. Unfortunately, the electrical power generated cannot be economically used elsewhere, and will therefore be dumped. Wasting multi-megajoules of energy and raising the entropy of the universe prove to be bitter pills for even a large-throated thermodynamicist to swallow!" Scott and Jean planned to travel to Europe this summer . . . **Dorothy Comeau** Fuhrman married Jed Fuhrmann '77 in La Jolla, Calif. in August 1981. Dorothy just got her M.S. in biology from UCSD, and at press time was looking for a job near Stony Brook, N.Y., where Jed is assistant professor of marine sciences. Reports Dorothy, "I was the 'thrilled' winner of an M.I.T. tie (complete with little silver 'engineers of the animal world') at a recent telethon for the Alumni Association. As you can see, I'm movin' on up'!"

Another second-year Harvard B-School student is **Bonnie Mason**, who writes, "Reports of my demise have been greatly exaggerated! I am alive and living in good old Cambridge. Not married yet—you'll be the first (actually the second) to know!" . . . **William Kleinman** is a third-year law student at the University of Texas. . . . **Paul Denney** is working for the U.S. Naval Research Labs in Washington, D.C., and sharing an apartment with James Moody '75. . . . At press time, **Andreas Hegedus** was planning to crew on a friend's sailboat in races this summer, in addition to attending school.

Joshua Koslov is in the Digital Video Group at RCA Labs in Princeton. Writes Joshua, "One highlight was giving a paper last year at the International TV Symposium in Montreux, Switzerland" . . . **Pamela Berry** is in her third year of a three-and-half-year, dual-degree program: a law degree at University of Connecticut School of Law, and masters in public policy at Trinity College. . . . **Gerald Dyer** has been working at Hamilton Standard as a mechanical design engineer, designing fuel control systems for jet engines. Gerald bought a house last year in Enfield, Conn. . . . **Jeff de Roulet** writes, "It has been a sunny, snowy winter here in Seattle. The skiing has been outstanding. I bought an old house in Seattle in December and passed the State Real Estate License exam in March. Also, I now have two buildings under construction with more on the boards for summer. My best regards to classmates all over the country."

Jeanne Brady is "still working at Northrop Corp. in the systems mechanical design and analysis group and taking grad courses in mechanical engineering at the 'Tute. After three years of full-time work, I'm beginning to miss being a full-time student! I'd like to hear from some of the ol' NRSA buckaroos—where is everybody?!" . . . **Charlie Bright** was in Hanford, Wash., working on installing an 1150 MW turbine

Charles Frankel, 1982 class president presents to President Paul E. Gray a total of $4,100 and pledges of over $17,000 in the next four years from members of the Class of 1982. Matched by members of the Class of 1928, the seniors' funds have been used to complete memorials to alumni lost in Korea and Viet Nam in the lobby of Building 10, and to provide new furnishings which make that lobby a more informal social center in the academic buildings. (Photo: Scott Globus, '84)

generator, and going to Seattle on weekends for sailing and skiing. In April, he was sent to Boardman, Ore., to reblade a turbine of 530 MW unit. "This peculiar unit has torsional natural frequency failure of row five in the high pressure section. No profit for Westinghouse Steam Turbine on this unit!" . . . **Jeffrey Greene** spent three years in an engine dynamics group with Cadillac Motorcar. He recently left for Rhode Island to start a business that will make high quality reproductions of early Queen Anne furniture pieces. (That wins Jeffrey the Award for Most Unusual Occupation this month!)

On a more sober note, **Daniel Radler** is suing the MBTA for $20,000, claiming that a driver on the Harvard-Dudley bus was negligent for not assisting him when he was assaulted by a man and woman in July 1978. Daniel allegedly asked a woman on the bus to extinguish her cigarette and then asked the driver to stop her from smoking. The couple then assaulted him for about two minutes, while the bus driver did absolutely nothing. Daniel filed the case in September of 1978, but it is only now coming to trial. Good luck, Dan!

Your faithful secretary is writing this column from Chicago, where Mobil has graciously transferred me for six months to work in the treasurer's department of one of our subsidiaries, Container Corp. of America. I've been here all of five days. As I sit in my spacious one bedroom apartment filled with rented furniture, I wonder how I'll ever be able to return to my shoe-box studio apartment in Manhattan! Meanwhile, keep on writing—**Sharon Lowenheim**, 131 E. 83 St., Apt. 2G, New York, NY 10028

80

Norman Toplosky and **Debra Freeman** were married on June 21, 1981. Norman is currently employed as a mechanical engineer at the Naval Underwater Systems Center, New London, Conn., and will receive his masters degree in mechanical engineering from the Hartford Graduate Center (a branch of R.P.I.) sometime this year. He plans to eventually return to M.I.T. to work on a doctorate in mechanical engineering. Debra is a second year medical student at the University of Connecticut School of Medicine and started her surgery rotation this past July. The couple resides in Farmington, Conn., with their Brittany spaniel, Sam.

Mark Lehrer is studying foreign languages at Berkeley and enjoying it immensely. Mark writes that it beats marginal-cost curves anyday! . . . **Susan Weil** is working in data management at the Michigan Hospital Association. . . . **Richard Tucker** is "enduring with verve" at MITRE in Washington Center. . . . Some people just can't stay away from the hub. **David Krowitz**, having worked for McDonnell Douglas for a while, is now back at M.I.T. . . . **Peter Schechter** is also back in the Boston area, now attending Boston University Law School. . . . **Amy Hendel** has returned to Boston, doing actuarial work for John Hancock.

In nearby Rhode Island, **Evan Hannerman** is now the machinery division officer on board the Navy's USS *John King*, a guided missle destroyer deployed to the Mediterranean and the Indian Ocean. . . . **Marion Rideout** has recently been on two research cruises. The first, January-March 1981, on the *Endeavor*, research vessel of the Graduate School of Oceanography, was from the Ivory Coast of Africa to the Asceasion Island to Rio deJaniero, Brazil. The second, on the *Glomar Challenger*, a leg of the Deep Sea Drilling Project from September to November 1981, was from Ponta Delgada, São Miguel, Arores, to St. Thomas in the U.S. Virgin Islands and through the Panama Canal. Beside the globe trotting, Marion writes that she is working on her Ph.D., and is also an M.I.T. educational councillor. "To say the least, I've been busy!"

As for me, I'm sweltering with another humid Boston summer. I am making the best of it, though, hitting the beaches and making myself a nice glowing red. (That is the goal, isn't it?) Besides work, I've been getting as much time in as possible on the softball diamond. When not doing that, I'm at home reading the class notes mail that is always pouring in. (Sarcastic? Who? Me?) I can still be found at the same address.—**Ken Turkewitz**, Secretary, 3 Winslow Rd., Belmont, MA 02178

81

Summertime . . . and the livin' is easy. Catfish are jumpin' . . . As this column is being written, Boston has just survived a major heat wave. By the time this column is published, these sweaty July nights will be fond memories with fall already underway. The mailman brought news of a few of our classmates this month.

William Rathbone was commissioned as an Ensign in the U.S. Navy a year ago last May and has completed six months at the Navy Nuclear Power School in Orlando, Fla. William is currently working at the Naval Reactor Facility in Idaho Falls, Idaho, qualifying on the S1W prototype reactor. . . . **Kevin Pykkonen** is employed by Schlumberger, Ltd., and is working near Lake Maralaibo, Venezuela. Kevin is doing wire line logging of oil wells and was working in Argentina before moving to Venezuela.

June Cubillos is currently enrolled at Northeastern University Graduate School of Engineering, majoring in environmental engineering. . . . Diagonally from June (well, sort of) **Craig Stevens** is attending Northwestern University Medical School and is reportedly having a wonderful time. Craig, like **Julie Neuringer** at Dartmouth is eating well. . . . Well, that's all folks.—**Chuck Markham**, Secretary, 532 Beacon St., Boston, MA 02215

82

Welcome to the second edition of the class notes. The War Memorial in Lobby Ten is in place now; the furniture's on its way. Thanks again to everyone whose gifts made it possible. There's lots of news from classmates this month.

Angie Liao is in GE's Chemical Technology Program. She'll spend a year in R and D and then go on to the plastics business operations. . . . **Doug Rohall** spent the summer working for a D.C. law firm. He's at Yale Law School now—they made him a better offer than Harvard Law. Must have been nice to have such a choice. I heard a rumor that he wants to be a public defender in the Bronx when he grows up. But you never know if rumors are true. . . . **Mark Rahner** is at the 'Tute in aero/astro grad school. . . . **Colynne "Coco" Becker** is in sunny San Francisco working for Megatest. (You remember Megatest, the company with the unusual recruitment ads. You remember, "come in your jeans") . . . **Jeff Mai** is at M.I.T. grad school in chemical engineering. . . . **Stephanie Pollock** is up the river at Harvard Law School. . . . **Karl Frey** is working at the M.I.T. Planning Office.

Al Lester says he's been bicycling all over (keep in mind that he wrote to me in July). He says that since he was too busy last year trying "desparately" to graduate he didn't have time to bother with trivia such as looking for a job. He visited **Bill Jeffrey** who's working at the Watergate building "doing all sorts of things he can't talk about." Bill also spends a bit of time in his jacuzzi. Al also visited **Mike Colvin** in Baltimore. Mike worked at Johns Hopkins for the summer and is at Berkeley now. Mike taught the fine art of eating crabs, mussels and oysters. Al's not too crazy about oysters. Al has really made the social circuit this summer. He also visited Charles Zukowski '81 in Yorktown Heights, N.Y. Al hopes to be back at M.I.T. in time for Desmond House R/O events.

Rob Duncan is at grad school at UC Santa Barbara. . . . **Rodney Olson** heard wedding bells back in May. . . . **Sue Jackson** is working at M.I.T. in the Civil Engineering Department and sends news of other '82ers. She says that **Sue Koppel** is in Fort Worth working for General Dynamics. **Maripat Corr** is at North Carolina University Medical School, and **George Giacoppe** is also at Medical School in Maryland at the Army School.

Mark Hurle is at Penn State in the Chemistry Department grad school. . . . **Amy Thuer** spent the summer in Greece (some people know how to live). . . . **Noel Hsu** is at M.I.T. for chemical engineering grad school. . . . **Jay Morgenstern** is heading off to UC San Francisco for some biology (grad school, that is). . . . **Howard Benjamin** is also going there for grad school. But Howard's going to Berkeley. . . . Not to be outdone by these people moving to exciting and exotic places, I've taken an apartment in lovely Central Square, Cambridge. In another move for a change of scenery, I'm working at the Alumni Association. (*The* Alumni Association, not Harvard, M.I.T.). I do a pretty convincing imitation of a telethon coordinator there. Keep in touch! If you're too lazy to write, call (617) 497-0034.—**Rhonda Peck**, Secretary, 38 Bigelow St., Cambridge, MA 02139

The Squeeze Comes On: How to Cut $11 Million in Three Years?

A belt-tightening program aimed at eliminating annual deficits which might be as high as $6 million by 1985 is now in place at M.I.T. Operating expenses will be reduced by some $11 million over the next three years, says William R. Dickson, '56, newly appointed as senior

vice-president of the Institute.

Major budget reductions will be concentrated in administrative and support services, according to Mr. Dickson. "The quality and effectiveness of our teaching and research form the bedrock on which M.I.T. stands," Mr. Dickson says; "they are a national resource the university is committed to preserve and maintain."

But Professor Francis E. Low, provost, admitted to the *Wall Street Journal* that there will be some reductions in faculty, too—presumably by attrition. Debate has begun, he said, on how to establish priorities among the departments and laboratories, some of which—including microelectronics, robotics, and some areas of biology—will have to grow instead of shrink.

Cutting 400 Jobs Through 200 Layoffs

The chief candidate for paring is the $73 million annual spending for administrative and support services, with cuts of 5 percent a year programmed for the fiscal years ending in 1983, 1984, and 1985. These include building services, admissions, student affairs and financial services, public and alumni relations, financial administration (planning, budgeting, accounting, auditing, and purchasing), personnel, information processing, library services, and central administration.

There will be program changes and layoffs among administrative and support personnel in many of these areas, Mr. Dickson warns—perhaps as many as 400 jobs may have to be eliminated, and only half of them can be dropped by attrition. In all, there were as of mid-summer some 2,550 positions in affected administrative and support areas.

The basic problem, says Mr. Dickson, is that M.I.T.'s income has not kept up with inflation in expenses. Preliminary estimates put the deficit for the year ending in June, 1982, at $2 million—an amount which has to be met "by partial liquidation of the assets of the Institute," he explains. A principal factor is the need for increased financial aid to students to compensate for cutbacks in federal aid; indeed, financial aid expenses are likely to go up by $1 million—about 20 percent—in the current fiscal year, Mr. Dickson says.

Another problem is the increasing costs of supporting research, since contracts no longer cover the full cost of government-sponsored programs. Notable omissions are the cost of renovation or new construction to accommodate new programs, he explained.

Orienting Tasks to Money

M.I.T.'s approach to the problem of eliminating $11 million in three years is through "task-oriented" budgeting. The idea is to identify various support tasks directly with their costs so that selective reductions can be made by identifying functions to be preserved, reduced, eliminated, or—in a few cases—enlarged, Mr. Dickson explains.

Mr. Dickson is not new to the budget-cutting process. As vice-president for operations and before that director of physical plant, Mr. Dickson has had a central role in continuing programs to reduce M.I.T.'s outlays for materials and services during the past 12 years. His new title of senior vice-president "more accurately reflects Mr. Dickson's current responsibilities with regard to the administrative operations of the Institute," President Paul E. Gray, '54, said in announcing the change in the spring.

In his 1982 report for the Alumni Fund Board, Joe F. Moore, '52 (right), told President Paul E. Gray, '54 (that's Mrs. Gray with them at the Technology Day luncheon) that the year's record proved the strength of alumni commitment to M.I.T. That "augers well," President Gray replied, "for our ability to offer a high quality education for future generations." (Photo: Scott Globus, '82)

Alumni Fund: Sustaining a Tradition of Topping Itself

Alumni set new records of giving to the M.I.T. 1982 Alumni Fund, earning for the fund a Grand Award for Sustained Performance from the Council for the Advancement and Support of Education and for themselves and an accolade from President Paul E. Gray, '54: ". . . a wellspring of positive feeling toward the Institute among the alumni . . . augurs well for our ability to offer a high quality education for future generations of Tech students."

Total giving to the Alumni Fund from July 1981 through June 1982 was $7,715,000 up from $7,287,000 in the previous year. There were 25,843 donors, an increase of more than 1,000 in one year. Both were records—a rising total of giving for eight consecutive years and increasing participation for the fourth straight year. In the three-year period since 1979, the number of alumni contributing to the fund has grown 18 percent—an average increase of 1,300 per year.

In his report to Dr. Gray, Joe F. Moore, '52, chairman of the Alumni Fund Board, cited three further records set by the Alumni Fund in 1981-82—evidence, he said, "that we alumni recognize the continuing financial needs of M.I.T. and are committed to meeting them." The milestones:

☐ Of the 1982 fund's donors, nearly 2,000 were making their first gifts ever to the Institute, and 877 were members of the five youngest classes. Both figures exceed last year's records, said Mr. Moore.

☐ There were more than 6,500 gifts of $100 or more, a one-year increase of 15 percent and a jump of 56 percent since 1979.

☐ More than $1 million was received in corporate matching gifts, thanks to the conscientious efforts of alumni to tap this additional source of funds for the Institute. This year's matching gift total represents "a dramatic one-year increase of 30 percent and more than doubles the total received in 1979," Mr. Moore said.

The increase in larger gifts to the Alumni Fund was reflected in growing rosters of the Great Dome Associates and the M.I.T. Sustaining Fellows (*see pp. A19-A24*). Indeed, there were nearly 2,300 gifts of $250 or more to the 1982 Alumni Fund—9 percent of the total number of gifts, a "dramatic" increase from last year's figure of 1,800, says Joseph S. Collins, director of the fund.

Total alumni giving to the Institute in 1981-82 was $14,809,000, according to Glenn P. Strehle, '58, treasurer.

President Gray believes "the dramatic upward shift" in Alumni Fund participation represents a response to his appeal for replenishment of the "hidden scholarship" that every alumnus received as a student. Just as alumni benefited from funds in excess of tuition when they were students, so do today's students, Dr. Gray explained, and the process can continue only if the capital from which those funds come is continually replenished.

Messrs. Moore and Collins joined in expressing thanks to thousands of alumni who volunteered time and effort to the 1982 fund program. Over 1,150 such alumni called fellow-alumni during telethon programs in 23 cities throughout the U.S. and Canada—a 41 percent increase in the number of volunteers in just one year. They reached 16,000 alumni, over 11,000 of whom pledged gifts. In all, nearly 2,000 alumni and student volunteers made calls and visits on behalf of the Alumni Fund during 1981-82, giving what President Gray calls "the precious gift of their time in service to the fund."

M.I.T. Sustaining Fellows as of June 30, 1982

The M.I.T. Sustaining Fellows program was established in 1979 to recognize individuals whose support of the Institute is particularly exemplary. Sustaining Fellows membership is extended to alumni and other friends of M.I.T. making annual gifts of $2,000 or more for unrestricted purposes or for endowment in support of professorships, scholarships, or general purposes; life membership is offered to donors whose cumulative gifts for any purpose exceed $25,000. Names of donors who wish to be anonymous are not shown.

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1908
Mr. Leo Loeb*
Mr. and Mrs. Harold S. Osborne*

1912
Mr. Jerome C. Hunsaker*

1913
Mr. Julian E. Adler*
Mr. Raymond B. Haynes*

1914
Mrs. Vashti L. Magoon*

1915
Mr. C. Ellis Ellicott*
Mrs. Edmund R. Stearns*
Mr. Robert Welles*

1916
Mrs. J. B. Carr*
Mr. Ralph A. Fletcher*
Mr. Barnett D. Gordon*
Mrs. Francis E. Stern*

1917
Mr. and Mrs. Walter J. Beadle*
Mr. A. Raymond Brooks*
Mr. E. P. Brooks*
Mr. Stanley M. Lane*
Mrs. Richard T. Lyons
Mrs. William H. McAdams*

1918
Mr. and Mrs. Julian M. Avery*
Mrs. John W. Kilduff*
Dr. and Mrs. Harold C. Weber

1919
Mr. Benjamin H. Bristol*
Mr. and Mrs. Royden L. Burbank*
Mr. John L. Riegel*
Mr. and Mrs. Dean K. Webster, Jr.*
Mr. Lester Wolfe*

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Mr. Henry W. Hills*
Mr. and Mrs. Edwin D. Ryer*
Mr. L. G. L. Thomas*

1921
Mr. Wallace T. Adams
Mr. T. B. Davis*
Mr. Sumner Hayward
Mr. Irving D. Jakobson*
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Mr. and Mrs. Edmund J. MacDonald
Mr. Robert L. Moore*
Mr. and Mrs. Antonio Helier Rodriguez*
Mrs. Raymond A. St. Laurent*
Mrs. Arthur G. Wakeman*
Mr. and Mrs. Robert E. Waterman

1922
Mr. and Mrs. Edward L. Bowles*
Mr. Donald F. Carpenter*
Mr. Whitworth Ferguson*
Mr. Crawford H. Greenewalt*
Mr. Oscar H. and Mrs. Mary C. Horovitz*
Mr. and Mrs. Albert J. R. Houston*
Mr. H. W. and Mrs. S. Catharine McCurdy*
Mr. Theodore T. Miller*
Mr. and Mrs. Thomas H. West*

1923
Mr. and Mrs. Jonathan Y. Ballard*
Mrs. Philip L. Coleman*
Dr. and Mrs. Cecil H. Green*
Mr. Earle A. Griswold*
Mr. and Mrs. Harry Kalker
Mr. Ragnar D. and Mrs. Margaret Naess*
Mr. Alfred E. Perlman*
Mr. and Mrs. Robert C. Sprague*
Dr. and Mrs. Julius A. Stratton*
Mr. Chaplin Tyler
Mrs. Uncas A. Whitaker*

1924
Mr. Gordon Y. Billard*
Mr. and Mrs. Philip D. Blanchard*
Mr. and Mrs. Austin G. Cooley*
The Honorable Luis A. Ferré*
Mrs. Edward J. Hanley*
Mrs. Harold L. Hazen*
Mrs. Andrew P. Kellogg*
Mr. Paul Tishman*

1925
Mr. Marion W. Boyer*
Mr. John M. Campbell*
Mr. Edward H. deConingh
Mr. and Mrs. Frederick W. Greer*
Mr. Edward M. Lee
Mr. and Mrs. Karl R. Van Tassel*
Mr. and Mrs. Samuel R. Spiker*

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Mr. and Mrs. Robert T. Dawes*
Mr. and Mrs. William E. P. Doelger*
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Mr. David A. Shepard*
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Mr. and Mrs. James P. Warner*
Mr. and Mrs. John B. Wright*

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Mr. S. S. Auchincloss*
Mr. Arthur J. Connell
Mr. and Mrs. Arthur G. Connolly
Dr. and Mrs. Harold E. Edgerton
Mr. and Mrs. Harold W. Fisher*
Mr. B. Allison Gillies
Mr. and Mrs. Thomas A. Knowles
Mr. John W. Norris, Sr.*
Mr. Howard W. Page*
Mr. Russell P. Westerhoff*
Mr. and Mrs. Clarence L. Wynd*

1928
Mr. Homer A. Burnell*
Mr. and Mrs. Roland D. Earle
Mr. and Mrs. Tom Garrard*
Mr. Elisha Gray II*
Mr. and Mrs. Henry N. LaCroix*
Mr. Carl M. Loeb, Jr.*
Mrs. Edward J. Poitras*
Mr. and Mrs. Walter J. Smith*
Mr. and Mrs. Abraham Woolf*

1929
Mr. Seymour A. Baum*
Mr. David F. Bremner*
Mr. J. Russell and Mrs. Dorothy V. Clark*
Mr. Harry F. Dickinson*
Mr. Walter H. Gale*
Mr. and Mrs. Dexter T. Osgood*
Mr. John J. Wilson*

1930
Mr. Alan C. Bemis*
Mrs. Ernest B. Dane*
Mr. and Mrs. Allen Latham, Jr.*
Mr. Gordon K. Lister*
Mr. W. Wallace McDowell*
Mr. Walter W. Soroka*
Mr. and Mrs. Richard M. Wilson
Mr. Ching T. Yang*

1931
Mrs. James B. Fisk*
Mr. David W. Bernstein*
Dr. and Mrs. Gordon S. Brown*
Mr. George M. Bunker*
Mr. and Mrs. Emilio G. Collado*
Mr. Daniel S. Connelly*
Dr. and Mrs. Norman D. FitzGerald
Mr. and Mrs. Kenneth J. Germeshausen*
Mr. J. K. Jamieson*
Mr. and Mrs. Claude F. Machen*
Dr. and Mrs. Donald B. Sinclair*
Mr. Harold M. Wilson

1932
Mr. Bennett Archambault*
Mr. Cecil Boling*
Mr. Donald W. Brookfield
Mr. and Mrs. Howard F. Carver
Mr. and Mrs. Alexander D. Daunis*
Mr. John Navas*
Mr. and Mrs. Eric P. Newman*
Mr. Robert B. Semple*

1933
Dr. and Mrs. Dayton H. Clewell*
Mr. Ralph and Mrs. Eloise Cross*
Mr. Pierre S. du Pont*
Mr. Herbert E. Grier*
Mr. and Mrs. Cyrus S. Hapgood*
Mr. Warren J. Henderson*
Mr. and Mrs. George Henning
Mr. and Mrs. C. D. Marshall*
Mr. and Mrs. Malvin J. Mayer*
Mr. Richard S. Morse*
Mr. and Mrs. Harris A. Thompson
Mr. James E. Turner*

1934
Mr. and Mrs. James Eder
Mr. Samuel A. Groves*
Mr. and Mrs. Albert A. Hopeman Jr.
Mr. Donald K. Lister
Mr. Frank R. Milliken*
Mr. William H. Mills*
Mr. Richard H. Sanders*
Mr. Harold E. Thayer

1935
Mr. and Mrs. Leo M. Beckwith*
Mr. Hal L. Bemis*
Mr. Wesley H. Loomis III*
Mr. and Mrs. John F. Taplin*
Mr. Max Wasserman*

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Mrs. William W. Garth, Jr.*
Mr. and Mrs. Henry F. Lippitt, 2nd*
Mr. and Mrs. G. Elliott Robinson
Mr. and Mrs. Louis E. Stahl*

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Mr. Paul W. Allen*
Mr. and Mrs. W. B. Bergen*
Mr. Alanson W. Chandler*
Mr. Ralph B. Chapin*
Mr. and Mrs. Robert Cloud*
Mr. George S. DeArment*
Mr. James M. Ewell*
Mr. and Mrs. Herbert F. Goodwin*
Mr. William E. Hartmann*
Mr. Joseph F. Keithley*
Mr. and Mrs. William J. McCune, Jr.*
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Mr. and Mrs. Haskell R. Gordon*
Mr. and Mrs. Norman B. Leventhal*
Mr. James C. Longwell
Mr. Cornelius Van S. Roosevelt*
Mr. and Mrs. David A. Wright*
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Mr. and Mrs. Harold J. Muckley*
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Mr. Thomas F. Creamer*
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Mr. W. H. Krome George
Mr. I. M. Pei*
Dr. and Mrs. Karl Pfister*
Mr. and Mrs. Edwin H. Seim*

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Mr. Joseph G. Gavin, Jr.*
Mr. Daniel F. Flowers*
Mr. Fred Fort Flowers*
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Mr. and Mrs. Frank S. Wyle*

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Mr. Frederick M. Dierks*
Mr. and Mrs. Morton E. Goulder*
Mr. Floyd A. Lyon*
Mr. Jonathan H. Noyes*
Mr. Edward L. Pepper
Mr. and Mrs. Edward O. Vetter*

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Mr. and Mrs. J. Robert Gunther*
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Mr. Bernard M. Gordon*
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Mr. Peter Saint Germain*
Mr. and Mrs. C. Vincent Vappi*
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Mr. William R. Zimmerman*

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Mr. and Mrs. George F. Clements, Jr.
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Mr. George N. Hatsopoulos*
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Mr. and Mrs. Jack C. Tang*

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Mr. William D. Walther*

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Mr. Breene M. Kerr*
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Mr. and Mrs. Albert L. Zesiger

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Dr. Yaichi and Mrs. Masako Ayukawa*
Mr. and Mrs. Herbert H. Dow*
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Mr. and Mrs. Joe F. Moore

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Mr. and Mrs. James D. Kolb
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Mr. Ronald A. Kurtz*

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Mr. Ray and Mrs. Maria Stata

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Mr. Fred Kayne*

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Mr. and Mrs. John S. Reed*

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Mr. William I. Koch*

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Mr. Paul Rudovsky*

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Mr. Charles Ying*

1968
Mr. Richard Ying*

1969
Mr. and Mrs. Robert A. Swanson

1972
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Mr. Armand Bartos '35*

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Mr. Robert C. Gunness '34*
Mr. John C. Haas '42*
Mr. C. J. Harrington '38*
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Mr. Jan W. Mares '60*
Mr. Charles B. McCoy '32*
Mr. Ralph D. Patch '32*
Mr. Charles E. Reed '37*
Mr. Arch C. Scurlock '43*
Mr. George R. Vila '33*

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Mr. Howard S. Turner '36*

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Mr. James G. McCurdy '48*

Earth and Planetary Sciences
Dr. and Mrs. Louis Berger '40*

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Dr. and Mrs. Thomas Marill '56*

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Mr. and Mrs. Abraham Dranetz '48*
Mr. John M. Fluke '36*
Mr. William R. Hewlett '36*
Dr. and Mrs. Davis I. Kosowsky '52*
Mr. Douglas T. Ross '54*
Professor and Mrs. John G. Trump '33*

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Mr. and Mrs. Martin Y. Tang '72*

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Mr. Philippe and Mrs. Katherine Villers '60*

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Dr. and Mrs. Phillip Hartley Smith '52*
Mr. and Mrs. John A. Stern '41

Meteorology
Dr. and Mrs. Norman E. Gaut '64*

Physics
Dr. and Mrs. Colgate W. Darden III '59*
Dr. Otto Morningstar '39*

Senior Executives Program
Dr. and Mrs. Cuthbert C. Hurd '59*

Sloan Fellows Program
Mr. and Mrs. Marshall Wren Gabel '39*
Mr. and Mrs. Wayne J. Holman, Jr. '39*
Mr. and Mrs. Charles E. Wampler '40
Mr. and Mrs. T. A. Wilson '53*
Mr. W. Maurice Young '61*

Urban Studies and Planning
Dr. and Mrs. Alan M. Voorhees '49*

Honorary
Mr. and Mrs. Howard W. Johnson*
Mrs. Conchita Z. Lobdell Pearson*
Dr. and Mrs. Jerome B. Wiesner*

Non-alumni

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Mr. David F. Austin*
Mrs. Quentin Berg
Mr. Peter S. Bing*
Mrs. Thomas d'Arcy Brophy*
Mr. and Mrs. William A. M. Burden
Mr. and Mrs. John H. Bush*
Mr. Louis W. Cabot*
Mr. and Mrs. Thomas D. Cabot*
Mr. Frank T. Cary*
Mr. and Mrs. A. H. Chatfield, Jr.*
Mr. Landon T. Clay*
Mr. Randolph P. Compton*
Mr. William A. Coolidge*
Mr. Douglas Drane*
Mr. Willis H. du Pont*
Mrs. Priscilla Maxwell Endicott
Mr. Robert E. Firmenich*
Mrs. Henry W. Gadsden*
Mr. Robert W. Galvin*
Mr. and Mrs. George P. Gardner, Jr.*
Mr. Anthony H. Gleason*
Ms. Marion Hanny*
Mr. and Mrs. Russell Hergesheimer
Mr. Richard A. Herman*
Mr. Samuel C. Johnson*
Mr. and Mrs. J. E. Jonsson*
The Aga Khan*
Betty and Max Kranzberg*
Mr. and Mrs. William S. Lasdon*
Mr. Albert and Mrs. Vera List
Mr. Edmund W. Littlefield*
Miss Gladys F. MacDonald
Mr. Henry J. McCarthy*
Mrs. Eugene M. McDermott*
Mr. J. Irwin Miller*
Mr. Francis L. Moseley*
Mr. and Mrs. W. B. Murphy*
Mr. William H. Nichols, Jr.*
Dr. and Mrs. Daniel Orloff
Mr. Milan Panic*
Mr. and Mrs. Saul Poliak*
Mr. Laurance S. Rockefeller*
Mrs. Agnes Saalfield
Mr. Louis E. Seley*
Mr. and Mrs. C. Maxwell Stanley*
Mr. and Mrs. Lauson H. Stone
Drs. Jerrold R. and Leona Zacharias*
Mr. Alejandro Zaffaroni*

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Mr. and Mrs. Franklin T. Towle*

1914
Mr. Charles H. Chatfield

1922
Ms. Marjorie Pierce

1923
Mr. and Mrs. Joel Y. Lund*

1924
Mr. and Mrs. Edward A. Abdun-Nur

1925
Mr. Donaldson F. Jones*
Mr. and Mrs. Edwin E. Kussmaul

1928
Mr. and Mrs. George P. Palo

1929
Mr. Warren W. Walker*

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Mr. Bartholomeo DeLorenzo
Mr. Robert B. Rypinski*
Mr. Myron T. Smith*

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Mr. and Mrs. David V. Buchanan
Mr. and Mrs. J. Franklin Cook
Mr. and Mrs. Howard B. Huntress
Mr. and Mrs. Richard T. Kropf
Mr. and Mrs. Myrle M. Perkins
Mr. Spencer S. Prentiss*

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Mr. and Mrs. Wendell E. Bearce
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Dr. Albert G. H. and Mrs. Ruth A. Dietz
Dr. and Mrs. Rolf Eliassen
Mr. Gaynor H. Langsdorf
Mr. and Mrs. William B. Pearce
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Mr. and Mrs. Frank J. Bleil
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Mr. Richard Bell
Mr. and Mrs. Thomas M. Burton
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Mr. Samuel Untermyer
Mr. Roger H. Williams
Mr. and Mrs. Carl H. Wilson

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Mr. Charles N. Debes

1936
Mr. and Mrs. Ford M. Boulware
Mr. James H. Grove*

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Mr. Alfred E. Busch*
Mr. P. H. Dreissigacker

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Mr. John B. McCrery*
Mr. and Mrs. W. Shamban*

1939
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Mr. James H. Laubach Jr.
Mr. and Mrs. Charles S. Mercer*

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Mr. Robert K. Deutsch*
Professor and Mrs. Samuel A. Goldblith*
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Mr. E. M. Wallace*
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Mr. Merlyn J. Block
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Mr. Arthur S. Spear*

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Mr. and Mrs. David M. Baltimore*
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Mr. Earl L. Bimson*
Mr. Charles Chubb*
Mr. and Mrs. Arthur Vershbow

1944
Mr. John A. Lednicky*
Mr. Thornton Stearns*
Mr. and Mrs. Paul K. Tchang*
Mr. and Mrs. Stanley W. Warshaw*

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Mr. Hector M. Orozco*
Mr. and Mrs. J. Spencer Standish

1946
Mr. and Mrs. David G. Black Jr.
Mr. and Mrs. Herbert J. Hansell
Mr. Marshall P. Tulin

1947
Mr. Harl P. Aldrich, Jr.*

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Mr. and Mrs. D. Dennis Allegretti
Mr. Nichols W. Caldwell*
Mr. Carl Hilton*
Mr. George M. Keller*
Mr. Warren J. King*
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Mr. Joseph Yamron

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Mr. and Mrs. M. G. Hulme, Jr.
Mr. and Mrs. Robert W. Mann*
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Mr. Marvin Grossman*
Mr. and Mrs. Frank E. Heart
Mr. Thomas P. Kelly
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Mr. and Mrs. R. P. Simmons

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Mr. Alex W. Dreyfoos, Jr.*
Mr. Paul E. and Mrs. Priscilla K. Gray*

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Dr. and Mrs. Russell G. Meyerand, Jr.*
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William S. Lalonde, Jr.
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Clarence W. Moore
Donald E. Moore
Luang Videt-Yontrakich
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Lawrence Glassman
Hector E. Hagedorn
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Arthur L. MacKusick
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George Irvin Gahm
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Stanley S. Knight
Norman B. Krim
Irving R. Kusinitz
Wilfred D. J. MacDonnell
Douglas C. MacMillan
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John O. McLean
Arthur Miller
Jean M. Raymond
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Adrian E. Ross
Frederick Spaney, Jr.
Theodore Steinberg
Albert M. Talbot
Charles A. Wesley
Proctor Wetherill

1935
George E. Agnew
Bissell Alderman
John H. Anderson
Willard F. Bixby
Chester E. Bond
James E. Castle
Arthur H. Cohen
William W. Cross
Phoenix N. Dangel
Harold K. Farr
Ellis M. Flink
Robert F. Flood
Sidney Grazi
Brydon Greene
Franklin F. Lovering
George N. Lykos
Bernard H. Nelson
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A Moebius strip symbolizes recognition by the Council for the Advancement and Support of Education for the M.I.T. Alumni Fund: the council's Grand Award for Sustained Performance, sponsored by the U.S. Steel Foundation. Left to right: Joseph S. Collins, director of the Alumni Fund; Nancy L. Russell, associate director; and William J. Hecht, '61, executive vice-president of the Alumni Association. In a note to President Paul E. Gray announcing the award, Mr. Collins said: "While it is our 'occupation' to seek support of M.I.T. by its alumni, this particular award carries with it a grant of $4,000, which offers us the unique opportunity to make a symbolic first contribution to the 1983 Alumni Fund." (Photo: Calvin Campbell)

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James W. Mar
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Frederick H. Thompson

1942
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Charles E. Bossi
Curtis D. Buford
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1944
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Robert M. Byrne
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Gordon Chun
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Han Tang Liu
Richard A. Lopez
Robert S. Nobles
Robert Oppenlander
E. Alfred Picardi
Bernard Rabinowitz
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Warren I. Signell
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John Woolston

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Nicholas V. S. Mumford, Jr.
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David A. Trageser

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F. Thomas Westcott

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Howard A. Zwemer

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Robert A. Wofsey
Backman Wong

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Allan Kriegel
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Richard D. Morel
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Richard K. Pitler
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Edward T. Thompson
Vernon P. Turnburke, Jr.
Emilio J. Venegas
James Veras

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David D. Adams
Norton Belknap
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Rowland M. Garratt
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Charles W. Ellis
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Laurence L. Rubin
Samuel Rubinovitz
Arthur H. Schein
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Paul G. Smith
Frank H. Thomas, III
D. R. von Recklinghausen
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John J. Welch, Jr.
Harry J. Zimmer

1952
Joseph F. Alibrandi
Richard C. Aquadro
Arthur I. Auer
Clyde N. Baker, Jr.
Jess L. Belser
Bock M. Chin
Richard E. Heitman
Clifford H. Heselton, Jr.
J. Burgess Jamieson, Jr.
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Richard E. Lyle
Kevork V. Nahabedian
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Bernard Werthan, Jr.

1953
David M. Berg
David M. Bernstein
Norman Doelling
Robert J. Gellert
Kent F. Hansen
Charles R. Johansson
David L. Klepper
S. Eric Kondi
Richard I. Linde
Douglas L. Meyer
Joseph F. Mullen
Robert R. Piper
Jean-Pierre A. Radley
Burton M. Rothleder
Bennett Sack
Paul P. Shepherd
James A. Zurbrigen

1954
Gordon Aitken
Barbara A. Black
John Blair
Wallace P. Boquist
Coleman Bresee
James W. Brown, Jr.
William J. Eccles
Inaki I. Elguezabal
Camillo A. Ghiron
Charles H. Goodman
John C. Kiley
James E. Klapmeier
Samuel J. Losh
Kenneth S. Marks
John E. Preschlack
William H. Ryer
David F. Springsteen
Harvey I. Steinberg
Robert W. Stewart, Jr.
Anthony Turano, Jr.
Robert D. Warshawer
David B. Whelpley

1955
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Richard I. Bergman
Robert F. Buntschuh
Zaven A. Dadekian
Alan S. Dana, Jr.
Gilbert Davidson
F. Eugene Davis IV
William T. Deibel
Edward C. Ehrlich, Jr.
Eduardo L. Elizondo
John M. Farmer
William Friedman, Jr.
Hipolito P. Gerard
Lloyd Gilson
Clarence A. Kemper
Charles C. Ladd
Roger D. Mackay
Sheldon H. Moll
F. R. Morgenthaler
Richard D. Nordlof
Theodore G. Papastavros
Farrel Peltz
Stuart S. Peltz
Karl A. A. Reuther
Gregory L. Robillard
Randall S. Robinson
Walter Rubin
Roy M. Salzman
Allan C. Schell
W. Chandler Stevens, Jr.
Harold A. Stubing, Jr.
David S. Wilbourn

1956
George G. Alexandridis
Robert D. Alter
Thomas E. Barker
Howard S. Bertan
Bernardo Blaschitz
Bruce B. Bredehoft
Theo A. De Winter
William R. Dickson
J. P. Diplarakos Weiller
Irwin Dorros
McIver W. Edwards, Jr.
Frank Foster, III
Stuart Frank
Walter P. Frey
Samuel S. Friedman
Margolia Cohen Gilson
Larry R. Goldberg
William S. Grinker
John W. Hartigan
Richard A. Jacobs
David L. Kaufman
John L. Kelly
Haim Kennet
William R. Leitch
Clifford K. Monzeglio
John A. Morefield, Jr.
John D. Mueller
William R. Oakes
Ira S. Polevoy
Martin H. Reiss
Axel E. Rosenblad
Jack L. Rosenfeld
Jesse A. Rothstein
David S. Shefrin
Richard E. Skavdahl
John D. Stelling
Howard A. Trachtenberg
Philip A. Trussell
Michael A. Turin
Thomas Yonker
Francis H. Zenie

1957
Arthur E. Bergles
Peter M. Bernholz
Bruce Blanchard
George H. Borrmann, Jr.
John T. Christian
Aurelio F. Concheso
John A. Currie
Rodney H. Dann, Jr.
John F. Day, III
Robert B. Dirks
William H. Doughty
Alan J. Dworsky
Ronald E. Enstrom
Gilbert G. Fryklund
Robert Gal
Richard S. Hirschhorn
Patrick B. Hutchings, Jr.
Frederick L. Jaggi
Eric G. Johnson, Jr.
Harry M. Johnson
Ronald W. Keefe
Robert A. Kruger
Bernard S. Levy
Steven C. Mason
Alan M. May
Terrence K. McMahon
Gerson E. Meyers
Frederick L. Morefield
E. Alan Phillips
Philip R. Pluta
Edward B. Roberts
John T. Roberts
Thomas S. Roberts
Robert H. Rosenbaum
Henry E. Salzhauer
Thomas S. Roberts
Peter A. Samton
Harold P. Smith, Jr.
Thomas L. Springall
Ralph J. Warburton
Stephen Weisskoff
Benjamin J. Woznick, Jr.

1958
Michael E. Brose
Stephen Corman
John F. Fallon, Jr.
John B. Forrest, Jr.
Robert E. Jordan, III
Stan Klein
Calvin J. Morse
John A. Murphy
Robert Bruce Parente
Cornelius Peterson
Bazil R. Zingali

1959
Hayward R. Alker, Jr.
George L. Barnett
Emile A. Battat
John W. Brackett
James H. Brown
Allan S. Bufferd
Paul H. Ekberg
Norman A. Fujiyoshi
Leon R. Glicksman
Martin F. King
Frank S. Koppelman
Donald E. Murray
Philip M. Richardson, Jr.
Earl J. Rogers
Paul G. Savage
Joseph P. Seidel
Lynn R. Sykes
Irvin B. Van Horn
Jonathan B. Weisbuch
George N. Yerid

1960
Terry F. Bower
Barry R. Bronfin
Thomas H. Farquhar
Standley H. Goodwin
Gordon W. Moore
Harold J. Parmelee
Erik T. Ringkjob
M. Elizabeth Schumacker
Susan E. Schur
Alan B. Shalleck
Richard F. Smith
Patrick S. Spangler
Robert S. Troth
John R. Wilt

1961
John W. Baxter
Dorsey C. Dunn
Reed H. Freeman
Jerome Goldstein
William J. Hecht
Maynard R. Johnson
William E. Jouris
Richard A. Mezger
Gerald E. Pollon
William M. Richardson
Joseph R. Skenderian
William Strauss
Craig S. Tedmon, Jr.
R. Rex Thompson
Stephen R. Waltman

1962
Robert E. Anderson
Stephen J. Banks
Thomas G. Burns
Vito A. Caravito
George S. Dotson
Edward A. Feustel
Albert F. Gleim
Robert L. Goldsmith
Theodore C. Goldsmith
Gerald L. Katell
Robert F. Morse
Philip H. Nelson
ChoKyun Rha
Martin N. Rosen
Arthur J. Samberg
Vijaykumar J. Shah
Thomas P. Sheahen
Daniel E. Thornhill

1963
Edwin F. Brush, Jr.
James A. Champy
Ching C. Chen
Frederick E. Cunningham
Steven R. Ditmeyer
Thomas P. Gerrity, Jr.
Thomas A. Goddard
Thomas Goldberger E.
Milton J. Grebler
Stephen P. Kaufman
John J. Lamberti, Jr.
Maurice H. Lanman, III
Luis J. Odon Acosta
James W. Poitras
Robert P. Porter
Russell E. Prins
Robert H. Rabiner
Alan O. Ramo
Charles C. Schumacher
Daniel W. Shelley
Warren D. Siemens
Peter T. Van Aken
Robert A. Warman
Grant M. Wilson

1964
Wayne F. B'Rells
Leslie M. Boring, Jr.
Ernest M. Cohen
Ronald H. Cordover

John N. Hanson
Mark Joseph
Brian R. Kashiwagi
Joseph L. Kirk
Stephen B. Miller
Kenneth J. Olshansky
Alton B. Otis, Jr.
Peter J. Sherwood
Jay M. Tenenbaum
Robert E. Thurber
Thomas C. Vicary
William L. Wallace

1965
Arthur A. Bushkin
W. David Carrier, III
Mark Eisner
Robert B. Grady
Dawn Friedell Jacobs
William N. Kavesh
Louis A. Kleiman
Peter A. Klock
Steven B. Lipner
John A. Ottesen
Donald L. Shulman
Douglas C. Spreng
Carol E. Van Aken
Michael G. Weiss
Ronald Wilensky
Stephen L. Williams
David L. Yuille

1966
Michael R. Adler
Arthur N. Boyars
Paul A. Branstad
William L. Bunce
Richard Y. Chung
Richard T. Cockerill
Peter M. Cukor
Ralph M. Davison
Steven H. Disman
Bert E. Forbes
Jonathan W. Hopkins
Robert D. Large
Ralph G. Schmitt
William R. Schnicke
Joseph W. Sullivan, Jr.
Frank E. Surma, Jr.

1967
William M. Bloomquist
James W. Carter
John M. Davis
Joseph Ferreira, Jr.
Alan B. Hayes
Edson C. Hendricks
Denny Meredith
William E. Murray, Jr.
Russel G. Perkins, Jr.
Chet Sandberg
Andrew D. Skibo
Joel M. Steinberg
Arthur S. Warshaw
James H. Williams, Jr.

1968
Harvey Allen
Bruce J. Anderson
Julian P. Freret, Jr.
Paul A. Gluck
Daniel M. Green
Peter Groot
Scott P. Marks, Jr.
Juan M. Meyer
Charles B. Miller, Jr.
Joel P. Robinson
Jonathan D. Shane
Michael Weinreich

1969
Dariush Ashrafi
William P. Bengen
Denis A. Bovin
Christopher W. Brooks
Bruce R. Donath
Andrew C. Goldstein
Stephen A. Hill
Bernard E. Klein
Aaron Kleiner
Carl W. Kuhnen, Jr.
Michael W. Laird
Franklin P. Rogers
Christopher R. Ryan
Michael Sporer
William H. (Tom) Thomas, Jr.
James P. Truitt, Jr.

1970
Gregory K. Arenson
Karen Arenson
David S. Bann
Wendell C. Brase
James L. Caldwell
Eric K. Clemons
Stephen F. Cooper
Irenee DuPont, III
J. O. Chike Enwonwu
Harry D. Feldman
Linda L. Furrow
Robert F. Gonsett
John C. Head III
David T. Patten
Christopher L. Reedy
James B. Rothnie, Jr.
Patrick K. Snead

1971
Richard A. Aparo
Thomas Hill Crosby
Edward T. Furrow
John M. Malarkey
Robert D. Marshall, Jr.
Frederick A. Middleton, Jr.
Laurence Storch
Stanley W. Tillotson
Charles W. Werner
Richard H. M. Willoughby

1972
John M. Bissell
Jack E. Cater
Leonidas P. Colakis
David A. Davis
G. Paul Hendrickson, Jr.
Gary J. Schuitema
Hikaru P. Shimura
Michael Sims
John W. Taylor
Robert E. Zahler

1973
Mary J. Crooks
Stephen P. Miller
Alan G. Spoon
James S. Wiley III

1974
Charles Shadell Bruno
James E. Clark
Piero Di Capua
Ian Fisher
Michiro Iwanaga
Gary David Raymond

1975
Stephen M. Chapman
Dale A. Coleman
Henry G. Heck
David L. Hendry
Donald W. Inadomi
Robert (Roml) M. Lefkowitz
Robert W. Mann, Jr.
Richard J. McCarthy

1976
Jeslie R. Chermak
Edward F. Crawley
Garret A. Davies
Jeffrey J. Held
Roseanna H. Means
Juzer S. Mogri
Janis Bestul Ossmann
George W. Todd, IV
James P. Wajda
Robert J. Winkler

1977
Paul J. Ackman
Charles B. Baltimore
Danny Bigio W.
Brian G. R. Hughes
Charles G. Mogged, Jr.
G. Scott Thompson

1978
James L. Bidigare, Jr.
Susan L. Kayton

1979
Jose I. Garcia-Rojas
James R. Murray
William I. Ogilvie

Aeronautics and Astronautics
Benjamin P. Blasingame '50
Thomas N. Coppedge, Jr. '54
Carlo N. De Gennaro '53
John A. Long '33
George S. Schairer '5
Leroy P. Smith '49
A. Tobey Yu '46

Architecture
Bill C. Booziotis '60
C. Rosalie C. Carson '47
Robert P. Cooke '62
John W. Peirce '47
Elliot Saltzman '51
Ewart A. Wetherill '58
Selby M. Wheeler '47

Biology
Peter N. Rosenthal '68
Trent S. Russell '42
Cecily Cannan Selby '50
Alfred M. Webb '47
Barbara A. Wolf '73

Chemical Engineering
William C. Beck, Jr. '62
Leonard Berkowitz '58
P. L. Thibaut Brian '56
James S. Bruce '39
Bernard Chertow '48
Jerry A. Cogan '32
Thomas E. Drisko, Jr. '43
John E. Fay, II '71
Robert L. Greene '47
Charles B. Henderson '52
Earp F. Jennings, Jr. '39
Herbert Kay '47
Ernest I. Korchak '61
James Lago '47
Donald M. Leslie '39
Paul N. Malherbe '51
Edward A. Mason '48
Edward W. Merrill '47
John E. Millard '35
Edward W. S. Nicholson '36
John H. O'Neill, Jr. '51
Rienzi B. Parker, Jr. '59
Donald W. Peaceman '51
Robert J. Richardson '54
A. David Rossin '55
William C. Rousseau '36
Keith E. Rumbel '70
Francis R. Russell '32
George F. Schlaudecker '39
John P. Schmidt '63
Hugh W. Schwarz '42
Robert E. Siegfried '47
Joseph J. Snyder '44
Arnold Stancell '62
William E. Tucker, Jr. '42
Douglass J. Warner '59
James C. Wei '54
Jack C. Williams '38

Chemistry
Clifton J. Blankley '67
Carl H. Brubaker, Jr. '52
Howard S. Corey, Jr. '55
Susan Fredericks Davis '80
Richard P. English '70
Lionel S. Galstaun '34
Henry C. Griffin '62
Emily L. Wick '51
John E. Wood, III '39

Civil Engineering
Arthur R. Anderson '35
William J. Aronson '53
Daniel Beltran '62
Albert H. Bryan, Jr. '48
Kenneth C. Deemer '52
David D. Driscoll '69
Thomas F. Gilbane, Jr. '75
Thomas D. Landale '54
William O. Lynch '47
William A. Moylan '80
John F. O'Leary '66
Arthur C. Ruge '33
De Vere W. Ryckman '56
William C. Stookey '51
Charles R. Walker '48
Stanley M. White '76
Roger H. Wingate '37

Earth and Planetary Sciences
Nicholas G. Dumbros '34
Bill Johnston '50

Economics
Robert W. Adams '51
Leslie Cookenboo '53
Vincent A. Fulmer '53
Thomas G. Hall '52
James W. Hanson '52
J. Wade Miller '48
George P. Shultz '49
John G. Turnbull '47

Electrical Engineering
Arthur H. Ballard '50
Vince Bogda '66
Charles A. Desoer '53
Anthony P. Di Vincenzo '47
Robert L. Frank '39
Stephen J. Jatras '52
Jean D. Lebel '53
Gordon M. Lee '44
Henry S. Magnuski '73
Kenneth E. McVicar '50
Charles W. Merriam, III '55
Cedric F. O'Donnell '51
Robert A. Price '53
John R. Whitford '49

Management
George A. Bobelis '58
Carol A. Bratley '81
Ralph N. Bussard '69
Edmund Cianciarulo, Jr. '65
Robert V. Clapp '63
William L. Clifton, Jr. '70
Maurice A. Garr, Jr. '49
Kenneth F. Gordon '60
Frederick L. Hall '67
Winston R. Hindle, Jr. '54
Stephen A. Landon '68
Judith C. Lewent '72
Maurice E. Maertens '66
John Norris Maguire '60
Karen Mathiasen '71
Wistar G. Metz '59
Donald H. Peters '69
John D. Proctor '73
Arnold O. Putnam '47
Daniel A. Rankin '72
Carlos F. Romero Moreno '66
Richard G. Schweikhardt '73
Lee L. Selwyn '69
Allen N. Strand '64
Shivan S. Subramaniam '78
James M. Utterback '69
Thomas R. Williams '54
Zenon S. Zannetos '55

Materials Science
J. Howard Beck '35
F. William Bloecher '49
John A. Fellows '32
David G. Meade '58
Robert C. Ruhl '67
Reinhardt Schuhmann, Jr. '38
Maurice E. Shank '49

Mathematics
Robert A. Clark '49
John H. Doles, III '69
Robert E. Sacks '75
Norton Starr '64

Mechanical Engineering
Robert H. Davis '50
Charles N. Griffiths '37
George E. Keeler '54
Marlen L. Miller '54
Alwin B. Newton '32
Jeffrey K. Raines '72
Chester A. Siver '35
Watson E. Slabaugh '30
Jan A. Veltrop '53

Meteorology
John M. Wallace '66
Leonard W. Weis '47

Naval Construction and Engineering
D. A. Ball '44
Charles A. Curtze '38
Frank Cox Jones '43
David R. Saveker '46

Nuclear Engineering
Harry J. Capossela '68
Martin Hudis '70
William T. Miles '73
John M. Neill '61

Nutrition and Food Science
Charles J. Bates '57
Darshan S. Bhatia '50
Jean-Louis Fribourg '72
Anthony J. Sinskey, Jr. '67
Lawrence D. Starr '55
David H. Wallace '63

Physics
James E. Archer '50
Solomon J. Buchsbaum '57
Fernando J. Corbato '56
Lincoln B. Hubbard '67
H. Richard Johnson '52
David J. Rose '50
Thomas W. Stinson, III '71
Parr A. Tate '53

Senior Executives Program
Andrew C. Knowles '76
James D. Reeves, Jr. '71

Sloan Fellows Program
Robert S. Ames '54
Robert B. Anderson '66
Ray W. Ballmer '60
Eugene D. Becken '52
William E. Benton '68
Somboon Bodhisompon '74
Robert E. Bryan, Jr. '69
Robert H. Campbell '78
Edward H. Carman, III '59
John C. Davis '56
Armen Der Marderosian '75
Donald A. Dick '68
David K. Easlick '55
John P. Eberhard '59
James C. Farley '50
Reinhard Frank '74
Stuart M. Frey '61
Carlos Garcia-Reyes '65
John H. Gerstenmaier '52
Leonard W. Golden '55
Walter K. Graham '39
Donald A. Henriksen '68
Wayne L. Horvitz '53
Howard H. Kehrl '60
Allan H. La Plante '78
William C. Mercer '56
L. William Miles '70
Shirley M. Picardi '81
John F. Prendiville, Jr. '62
R. Dewey Rinehart '56
Barry Rosenberg '67
Robert E. Scifres '50
Nicholas E. Shaw '78
W. Howard Sidner '80
Tom W. Sigler '64
Mary Oakes Smith '77
James I. Spiegel '64
John H. Thacher, Jr. '42
Sam R. Willcoxon '65
Hugh E. Witt '57
Robert E. Workman '58

Undesignated
Philip A. Le Bar, Jr. '69
Elizabeth J. Yeates '74

Urban Studies and Planning
Theodore S. Bacon, Jr. '56
Allen G. Gerstenberger '74
Barbara Z. Sedlin '60

Under the Domes

Y. E. Brown

There's a lot of tradition on display at the Royal Henley Regatta, but for rowers Christine Lofgren, '75 (right), and Joan Pendleton, '76, it was all hard work—first to qualify for the 1982 women's doubles and then to climb to second place (losing only to the Norwegians) in this most prestigious of competitions. ". . . the ultimate!" says Ms. Lofgren. (Photo: © Geo. Bushell and Son)

Alumnae at the Henley: ". . . There's Nothing Like It in the Entire World!"

by Ken Cerino

Former M.I.T. rowers Christine Plapp Lofgren, '75, and Joan Pendelton, '76, received a thrill of a lifetime last summer when they competed in the Henley Royal Regatta in England.

Henley, a tiny hamlet of 6,000 located 30 miles from London, is considered the "mecca of rowing." Since 1839, the elite in rowing have gathered here for the world's oldest and most prestigious rowing championship.

Tradition? Along the banks of the famed Thames River, her Majesty's Royal Band plays such songs as "Waggery for Woodwind" and "Waltzing Cat." English schoolboys proudly wear their blazers while other spectators lunch on strawberries and cream.

When Henley officials decided to allow women to compete "on a experimental basis" for the first time last year, they did so on their own terms; they picked "events in which the British women were good—single and double sculls and a four with coxswain—and then invited three other countries to participate," explained Lofgren. Undaunted, Lofgren and Pendleton turned their attention to earning a spot in the select field.

Representing the Long Beach, Calif., Rowing Association, Lofgren and Pendleton won a qualifying race last June on Lake Waramaug in Kent, Connecticut, to earn an invitation to Henley.

On July 3, they competed in the Women's Invitational double sculls and became the first M.I.T. women to row down the historic Thames River course. The fact they lost to a Norwegian team by two lengths was secondary—the fact they were *there* was all that counted.

"We knew it would be tough to win, but our goal was to qualify for Henley and we did it," said Lofgren. "We had to pay our own way, but it was worth it. For me, this was the ultimate and something I'll never forget.

"There were 12,000 people there the day we raced, and it seemed like they were only 10 feet away from our boat. It was frightening, but they weren't unruly. Spectators would say in a normal speaking voice, 'Well-rowed.'

"Large crowds *are* part of the Henley tradition along with the narrow course. There's nothing like it in the entire world," she said.

Both Lofgren and Pendleton started their rowing career while undergraduates at M.I.T.

Lofgren, 29, was a member of the first M.I.T. women's varsity crew team in 1974. She won the single sculls title at the 1979 National Sports Festival in Colorado Springs and the senior sculls crown at the 1980 Open National Championships in Oak Ridge, Tenn. Her husband, Karl, was a member of the M.I.T. varsity heavyweight team in 1975.

Pendeleton, 28, started rowing during her junior year at M.I.T. She competed in the Canadian Henley last August and the 1981 National Sports Festival in Syracuse, N.Y.

Rowers like Lofgren and Pendleton are among the most dedicated and best-conditioned athletes in the world. Both women, for example, work out approximately two hours a day during the year. Lofgren estimates that they train 700 hours for 24 minutes of competition.

Now living in California, both women plan to continue their rowing careers.

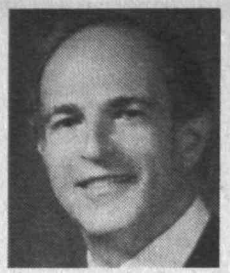
"The number of people from M.I.T. who row after graduation is high," said Lofgren. "My husband and I are amazed at the number of M.I.T. people we meet at different races."

Ken Cerino is M.I.T. Director of Sports Information.

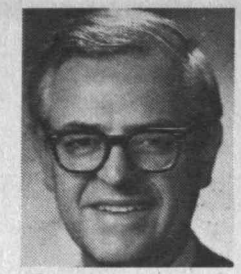
Our First Woman Rhodes Scholar

Yolande E. Brown, '82, of Kingston, Jamaica, who finished both S.B. and S.M. degrees in electrical engineering at the end of the summer, is now at Oxford as M.I.T.'s first woman Rhodes Scholar. She's studying management, and she intends to design computer systems, manage investments, and work in marketing in Jamaica after 1984.

B. W. Harleston



D. I. Kosowsky



E. K. Miller

R. A. O'Brien

F. Press

E. T. Thompson

Corporation Elections: Eight New Members, Seven Changes

Eight new members have joined the M.I.T. Corporation, and the terms of membership of seven members have been changed.

The new members (all for terms of five years) are:

☐ **Bernard W. Harleston,** president of the City College of New York. Dr. Harleston is a psychologist trained at Howard and Tufts Universities; he was dean of the Faculty of Arts and Sciences at Tufts before taking his present post. He is a member of the Massachusetts Minority Higher Education Advisory Council.

☐ **David I. Kosowsky,** Sc.D.'55, president and chief executive officer of Damon Corp. Dr. Kosowsky studied electrical engineering at M.I.T. and is now a member of the visiting committee to that department; he is a fouding life member of the M.I.T. Sustaining Fellows and also a member of the visiting committee on sponsored research.

☐ **E. Kirkbride Miller,** '41, chairman of the board of T. Rowe Price Associates, Inc. and of the T. Rowe Price Growth Stock Fund, Inc. Mr. Miller studied management at M.I.T. and later (for the M.B.A. degree) at Harvard Business School; he serves on the visiting committee to the Department of Economics and on the Board of Directors of the Alumni Association.

☐ **Rita A. O'Brien,** S.M.'77, vice-president for Rhode Island of the New England Telephone and Telegraph Co. Ms. O'Brien studied at Whitman College and Stanford University (M.S. in operations research, 1963) and received her M.I.T. degree as a Sloan Fellow.

☐ **Frank Press,** president of the National Academy of Sciences who was formerly Institute Professor and head of the Department of Earth and Planetary Sciences at M.I.T. Dr. Press headed the Seismology Laboratory at Caltech before coming to the Institute, and he was White House science adviser under President Jimmy Carter.

☐ **Edward T. Thompson,** '49, editor-in-chief and a member of the Executive Committee of the *Reader's Digest*. A graduate in chemical engineering, Mr. Thompson's editorial career began on *Chemical Engineering* and *Chemical Week* magazines; he joined the *Reader's Digest* in 1960, and he now serves on the visiting committee for the Department of Humanities and on the advisory board to *Technology Review*.

☐ **Frank S. Wyle,** '41, chairman of the board at Wyle Laboratories, El Segundo, Calif. Mr. Wyle founded Wyle Laboratories eight years after graduating from M.I.T. in mechanical engineering; he was its president until 1970 and chief executive officer until 1979. A founding member of the M.I.T. Sustaining Fellows, Mr. Wyle is a member of the visiting committee to the Department of Humanities and of the M.I.T. Council for the Arts.

☐ **Heidi R. Wyle,** Ph.D.'82 (no relation), whose M.I.T. degree is in the field of nuclear engineering. Ms. Wyle came to the Institute from Brown University, and she has made a distinguished record as a graduate student: a member of the Institute's Safety and Medical Advisory Committees, coordinator of the student presentation for the visiting committee to the Department of Nuclear Engineering, and a graduate tutor in Baker House.

Three members of the Corporation have been advanced to Life Membership:

☐ **W. Gerald Austen,** chief of surgical services at Massachusetts General Hospital and Edward D. Churchill Professor of Surgery at Harvard Medical School, a member of the Corporation since 1977.

☐ **William Van Alan Clark, Jr.,** S.M.'42, chairman of the TSC Corp. of Marion, Mass., a member since 1972.

☐ **Kenneth J. Germeshausen,** '31, founder and former chairman of E G & G, Inc., Bedford, Mass., a member since 1980. Mr. Germeshausen holds the Bronze Beaver Award (1975) of the Alumni Association.

Four Corporation members were re-elected to five-year terms which will expire in 1978:

☐ **Yaichi Ayukawa,** '52, president of the Techno-Venture Co., Ltd., Tokyo.

☐ **David R. Clare,** '45, president of Johnson and Johnson.

☐ **Angus N. MacDonald,** '46, president of Angus MacDonald and Co., Inc., Greenwich, Conn., former president (1981-82) of the Alumni Association.

☐ **Jerry McAfee,** Sc.D.'40, retired chairman and chief executive officer of Gulf Oil Corp.

Old timers' night at M.I.T. Alfred E. Vellucci (right), mayor of Cambridge, joined with M.I.T. to host the golden age senior citizens' picnic in the Athletics Center early last summer. And as cohost, Howard W. Johnson, chairman of the M.I.T. Corporation, joined his honor in a round of songs, providing evidence of town and gown cooperation which on more substantive issues is sometimes elusive.

F. S. Wyle

H. R. Wyle

H. H. Richardson

For Most Seniors, Recession Was an Idea for Someone Else

Though they graduated in the midst of a recession, most members of the Class of 1982 found a warm reception to the job market, according to Robert K. Weatherall, director of career planning and placement.

Indeed he says, "high-technology" companies of 1982 made a "colossal" push for new M.I.T. graduates.

But for some the spring was an uncertain time; as the recession deepened, some companies suddenly slipped out of the job market, and students who had not accepted early offers found themselves looking in a market that was suddenly slower. Oil companies, for example, caught by the oversupply of oil on world markets, postponed new projects and even retrenched within their own staffs, with a result that the bottom dropped out of the market for chemical and civil engineering graduates during the spring. That meant "a tremendous opportunity to pick up some good people" for firms that usually don't attempt to compete with major oil companies, Mr. Weatherall says.

In general, salary offers were higher for the Class of 1982 than for the Class of 1981, and the differential exceeded the rate of inflation.

There was a special problem this year for students interested in government and policymaking. There is no established "marketplace" for such students—the students themselves are hard to identify because each has taken a special, tailored curriculum, and most job opportunities are widely scattered in large and small companies, often where there are only modest resources for recruiting. Too, it's a time when many government jobs are being cut back—and industrial jobs in policymaking, too, says Mr. Weatherall.

But such points of difficulty represent only dark spots in what Mr. Weatherall thinks will be a "bonfire" as soon as the recession ends. "There's plenty of heat underneath," he says, "and as soon as the sun comes out again the fire can be expected to blaze anew."

That's because "the economy is becoming increasingly dependent on good engineering," Mr Weatherall says. "Things in everyday use contain more and more engineering; products which used to be simple have become engineering marvels.

"If the demand for engineers came chiefly from defense and other government programs, as in the 1960s, one could worry about its lasting. But it can be expected to continue because it is so broadly based. Private firms, designing products for the economy at large, edge out the governmnt as the largest supporter of research and development.

"The recession has quieted only temporarily a widespread concern in industry that there will not be enough engineers to meet the technical challenges and opportunities that lie ahead.

"So the future is bright in all the major fields of engineering—civil, chemical, electrical, industrial, materials, and mechanical. The electrical engineers have no monopoly on "high technology," and today's demand for engineers comes from parts of the economy. The Japanese have taught us that we must be equally inventive in every field of engineering."

Passing the gavel. Angus N. MacDonald, '46 (right), surrenders his authority as president of the Alumni Association to Denman K. McNear, '48, during the Technology Day luncheon on June 11. Mr. McNear, who received the gavel symbolic of his new office, is president of the Southern Pacific Transportation Co., the first West Coast alumnus to be made president of the Association.

The New President's Agenda: A Statement from Denman K. McNear

To M.I.T. Alumni and Alumnae:

As your president for 1982-83, I want to share with you the five key issues on which I will work during my term of office and in the two succeeding years when I will be a director-at-large of the association:

First, I want all alumni to recognize the truly national and international composition and impact of M.I.T. and its alumni.

Second, I want to strengthen our ties with graduate alumni.

Third, I want all alumni to share in the opportunities provided by M.I.T. for continuing contact and further education.

Fourth, I want each of us to understand the key role we as alumni play personally in supporting M.I.T. This voluntary support takes many forms including good will, good words, good potential students, and strong financial support. Each of us is a beneficiary of M.I.T.'s education and training. Most of us have been profoundly influenced by our M.I.T. experience as undergraduate or graduate students. Each of us should therefore be a benefactor to future M.I.T. generations.

Fifth, I want to visit with organized clubs and individual alumni throughout North America to emphasize the importance of these goals and of the effect which each of us can have in supporting them.—*Denman K. McNear*

Associate Engineering Dean

Professor Herbert H. Richardson, '55, who has headed the Department of Mechanical Engineering since 1974, is now associate dean of the School of Engineering, where he'll assist Dean Gerald L. Wilson, '61, in all phases of managing teaching and research in the Institute's largest and fastest-growing school.

Professor Richardson's current re-

search is in urban and intercity ground transportation systems; as head of the department, Professor Wilson says, he was especially successful in bringing together activities in engineering science with those oriented toward more pragmatic technical applications.

Professor Richardson joined the faculty in mechanical engineering in 1959, having served in the U.S. Army for one year after receiving his Sc.D. from the Institute. Since then he's been active in transportation research and in computer applications to mechanical engineering, was for three years head of the department's System and Design Division.

National Selection Committee

Three alumni chosen in national balloting last spring have now joined the National Selection Committee, and the task of choosing officers of the Alumni Association for 1983-84 is well advanced. The three winners: Susan L. Kannenberg, '61 (District 1), Bernard H. Nelson, '35 (District 2), and Leonard F. Newton, '49 (District 4).

Roman Jakobson, 1897-1982

Roman Jakobson, Institute Professor emeritus who was a monumental figure in linguistics and literary studies for 70 years, died on July 18 at Massachusetts General Hospital; he was 85.

Professor Jakobson, whose association with M.I.T. began in 1957, was also the Samuel Hazzard Cross Professor of Slavic Languages and Literatures and General Linguistics, emeritus, at Harvard. He is known as the founder of modern phonology, the study of abstract properties of the sounds of speech, a strong advocate of the existence of profound general laws governing human speech development.

In addition, Professor Jakobson was also a major contributor to the theory of linguistics and to the understanding of Slavic languages and literature. His work included some 500 articles and a number of books, and an additional book, *Dialogue*, consisting of converstations with his wife, Professor Krystyna Pomorska of M.I.T., about his life and ideas has been published this fall.

Two major figures in the M.I.T. Department of Linguistics and Philosophy—Professors Noam A. Chomsky and Morris Halle—were students of Professor Jakobson, and their presence at M.I.T. was at least in part responsbile for Professor Jakobson's spending most of his retirement years since 1970 in his M.I.T. office.

Born in Moscow, Professor Jakobson was exiled first to Czechoslovakia, then to Scandanavia, and finally in 1941 to the U.S. He studied at the University of Moscow; in Czechoslovakia he was influential in founding the Prague Linguistic Circle, and soon after coming to the U.S. he took a distinguished faculty post at Columbia University.

Professor Jakobson was widely honored for his work in both linguistics and the Slavic languages, including an honorary degree from Oxford, the Antonio Feltrinelli International Prize of the National Academy del Lincei in Rome (1981), and the 1982 Hegel Preis of the International Hegel Society and the city of Stuttgart.

Delbar P. Keily, 1908-1981

Delbar P. Keily, '34, associate professor of meteorology, emeritus, who was a specialist in aircraft and meteorological instrumentation, died at his home in Lincoln, Mass., on June 16. He was 74.

Professor Keily retired in 1973 after spending almost his entire professional career at the Institute. He was graduated in aeronautical engineering and soon thereafter became a research assistant in meteorology; then he joined the faculty in aeronautical engineering and finally transferred to the Department of Meteorology in 1946. Throughout his career he made significant contributions to meteorological instrumentation and was the designer of equipment for a number of significant experiments conducted by his colleagues.

Thomas F. Morrow, 1913-1982

Thomas F. Morrow, '35, retired group vice-president of Chrysler Corp. who was a member of the M.I.T. Corporation from 1963 to 1968, died on June 17 in Detroit; he was 69.

Mr. Morrow became a member of the Corporation Visiting Committee to the Department of Mechanical Engineering in 1959 and four years later was elected to a five-year term as a member of the Corporation. During that period he became chairman of the mechanical engineering visiting committee and also was made a member of committees on city planning and aeronautics and astronautics. He had served as president of the M.I.T. Club of Detroit and was chairman of a 1959 alumni regional conference there.

Mr. Morrow started as a production worker at Chrysler following graduation at M.I.T. in civil engineering and rose through the ranks to become responsible for all of the company's military work.

Russell F. Chihoski, 1962-1982

Russell F. Chihoski, '83, died on June 13 after a fall while rock climbing near Boulder, Colo.; he was 20.

Mr. Chihoski had planned to receive degrees in electrical engineering and computer science, physics, and mathematics. He was widely known as a student, resident of Baker House and personnel manager for *Ergo*, the campus conservative newspaper. Both his parents—Russell A. Chihoski, '54, and Caroline Disario Chihoski, '56—are alumni, and his maternal grandfather was also graduated from M.I.T.

Edward L. Horton, 1960-1982

Edward L. Horton, a second-year graduate student in physics, drowned while swimming with student colleagues in Eastham, Mass., on June 26. He was 23.

Mr. Horton entered M.I.T. from Grambling State University in 1981 and took a leadership role in the Institute's black student community almost immediately. At the time of his death he was vice-president of the Black Graduate Student Association and he had chaired several important activities, including an orientation program for entering minority students.

Deceased

Robert E. Morse, '11; June 7, 1980; 118 Tupper Rd., PO Box 554, Sandwich, Mass.
John W. Connolly, '12; June 26, 1981; PO Box 26, Ponte Vedra Beach, Fla.
Raymond O. Doane, '15; May 13, 1980; 114 Atlantic Ave., Boothbay Harbor, Me.
Frederick W. Childs, '16; May 3, 1981; East Corinth, Vt.
Howard T. Evans, '16; June 19, 1982; Carl Vinson Hall Apt. 372, 6251 Old Dominion Dr., McLean, Va.
Herbert A. Pieper, '16; July 19, 1982; 17 Hadden Rd., Scarsdale, N.Y.
Philip N. Cristal, '17; June 26, 1982; 522 N. River Rd., Manchester, N.H.
Malcolm J. Baber, '18; November 15, 1981; 804 Hill House, 201 W Evergreen Ave., Philadelphia, Penn.
Francis C. Burke, '18; June 20, 1982; 76 Spruce St., Watertown, Mass.
Webster B. Shippey, '19; August 29, 1981; Cedars End, Rapid City, Mi.
John S. Visscher, '20; April 19, 1982; c/o Hunt Nursing Home, 90 Lindall St., Danvers, Mass.
Wallace T. Adams, '21; July 5, 1982; 2606 Fleming Rd., Middletown, Ohio.
Laurence O. Buckner, '21; February 20, 1982; 3400 Eastern Blvd., B-11, York, Penn.
Thomas Dillwyn Dutton, '21; May 25, 1982; 11140 Pinehurst Dr., Austin, Tex.
Carolus L. Eksergian, '21; May 22, 1982; Sugar Trees Farm, RD 1, Stillwater, Penn.
Walter J. Hamburger, '21; January 18, 1982; 15 Crest Dr., Dover, Mass.
Juntaro Kawai, '21; July 21, 1963; 649 Amanuma, Tokyo, Japan.
Cecilio Alincastre, '22; May 9, 1980; Capitolville, Bacolod City, Philippines.
George L. Erikson, '22; April 6, 1979; Durcy Hall Nursing, 2170 Palm Beach Lakes Blvd., West Palm Beach, Fla.
James M. Waechter, '22; November 23, 1981; Gallahads Apt. 4-N, 3801 S Ocean Dr., Hollywood, Fla.
Robert W. Hart, '24; April 17. 1982; 123 Dartmouth St., Lynn, Mass.
Perry C. Maynard, '24; November 24, 1981; 80 Hollywood Dr., Hastings-On-Hudson, N.Y.
George M. Nash, '24; April 11, 1982; Heritage Village 484B, Southbury, Conn.
Chao Han Shih, '24; 1980.
Ralph E. McShane, '24; May 3, 1982; 17 Field Crest Ln., Bricktown, N.J.

Hodsoll Finds Science and Art in Partnership at M.I.T.

Among 90 grants (a total of $1,142,607) to arts organizaitons in Massachusetts from the National Endowment for the Arts is a $250,000 challenge grant for the arts and media center at M.I.T., now under construction. Reason enough for Francis S.M. Hodsoll, chairman of the NEA, to make a site visit to M.I.T. during a one-day trip in the state late last spring.

At a dinner arranged by the M.I.T. Council for the Arts following his tour of the Institute, Mr. Hodsoll proposed that artists and scientists have much in common. Both are "part of the effort to make American society spiritually richer," and both should be more a part of the basic school curricula at every level, he said. And both share the mysteries of the moment of creativity; physicist Gerald Holton calls it the "nascent moment," poet Maxine Kumine the "visit of the muse," violinist Yehudi Menuhin the "state of grace."

How can we nurture the moments of unpredictable creativity that characterize the arts and sciences? asked Mr. Hodsoll. His answer to his rhetorical question: the role of patronage "can hardly be overestimated," he said, and on the front there is encouraging news. The level of philantropy increased in the U.S. in 1981, he said, and there was a disproportionate increase in giving to the arts—a total of $3.35 billion in the year. At this rate, Mr. Hodsoll said, its "conceivable" that private gifts by industry and individuals could replace federal support of the arts.

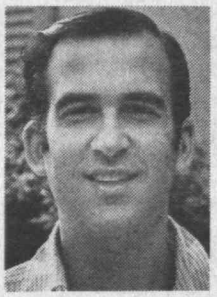
But in today's environment NEA's assignment "to help create and sustain a climate for art" leaves him bewildered. In a time when the government's role in American life should decrease, the challenge, said Mr. Hodsol, is to understand "what that climate can most helpfully be."

On a site vist to M.I.T., where the National Endowment for the Arts has made a $250,000 challenge grant toward new facilities for arts and media technology, Francis S.M. Hodsoll (right), NEA chairman, is hosted by Angus N. MacDonald, '46, a leading member of the Council for the Arts at M.I.T.

William F. Arnold, '25; November 4, 1981; PO Box 121, Charlestown, R.I.
Charles H. Flohr, '27; March 13, 1982; 902 W Remington #4-15A, Sunnyvale, Calif.
Vernon G. MacKenzie, '27; July 4, 1982; 400 Park Shore Dr., Naples, Fla.
Daniel C. Metzger, '27; March 27, 1982; 750 N Ocean Blvd., Apt. 1403, Pompano Beach, Fla.
Cal W. Caldwell, '28; April 13, 1982; 203 East Hickory St., Lombard, Ill.
James A. Cullen, '28; July 2, 1981; 82 Bacon St., Winchester, Mass.
Victor J. Gerdes, '30; May 4, 1982; 1602 SW 13th St., Boynton Beach, Fla.
Walter B. Parker, '30; November 11, 1981; 409 Main St., Keene, N.H.
Hymen Shrager, '30; May 8, 1982; 28 Railroad St., Methuen, Mass.
Spencer J. Buchanan, '31; February 4, 1982; 1105 Walton Dr., College Station, Tex.
Chauncey J. Hamlin, Jr., '31; April 16, 1982; 2513 Bayou Ln., Lake Havasu City, Ariz.
Charles Gideon Rice, '31; 1981; c/o SE Bank Trust, PO Box 4300, West Palm Beach, Fla.
James H. Rodgers, '31; June 10. 1981; PO Box 8462, South Lake Tahoe, Calif.
Clarence M. Chase, Jr., '32; June 21, 1982; 1710 Watchung Ave., Plainfield, N.J.
William B. Schneider, Jr., '32; April 16, 1982; Titterlew Farm, Basehor, Kan.
Carrel Jack Stover, '32; February 9, 1982; 1858 Old Orchard Rd., Arbington, Penn.
William P. DeCamp, Jr., '33; April 20, 1982; Randolph Hill, Randolph, N.H.
Gilbert W. King, '33; July 10, 1982; 700 Halliday Ave., Los Angeles, Calif.
Thomas F. Donlan, Jr., '34; December 3, 1981; 55 Westvale rd., Milton, Mass.
Delbar P. Keily, '34; June 16, 1982; RR #2, Lincoln, Mass.
Thomas F. Morrow, '35; June 17, 1982; 78 Vendome Rd., Grosse Pointe, Mich.
Benjamin Cooperstein, '36; May 27, 1982; 40 Woodfall Rd., Belmont, Mass.
John P. Hayes, '36; April 24, 1982; 3637 Palos Verdes Dr. N, Palos Verdes Estates, Calif.
Jackson M. Balch, '37; August 26, 1981; 790 W Beach, Pass Christian, Ms.
Louis C. Bartol, '37; May 7, 1982; 1460 Canton Ave., Milton, Mass.
Philip C. Jacobs, Jr., '37; July 15, 1982; 53 Walden St., Newtonville, Mass.
Jermain F. Rodenhauser, '37; July 8, 1982; 200 Midway Island Estates, Clearwater, Fla.
Allan M. Swift, '37; February 27, 1982; 2903 Wild Horse Rd., Orlando, Fla.
Frank G. Denison, '40; May 18, 1982; 3979 Chatham Way, Santa Maria, Calif.
Alan R. Lukens, '41; June 1, 1982; 52 Rockledge Rd., Newton Highlands, Mass.
David D. Moffat, Jr., '41, January 6, 1982; Salt Lake City, Utah.
Russell J. Estelle, Jr., '42; April 16, 1981; 1817 Loisdale Ct., Cincinnati, Ohio.
Roger E. Drexel, '46; June 29, 1982; 312 High Ridge Rd., Owls Nest, Wilmington, Del.
Morton Loewenthal, '47; May 18, 1982; 65 The Valley Rd., Concord, Mass.
John K. Reddersen, '47; March 18, 1982; 9121 Paddock Ln., Potomac, Md.
Harold B. Abramson, '48; June 19. 1981; 73 Fairfield Rd., Clifton, N.J.
Walter Norris McSweeney, '49; July 26, 1982; 1420 Providence Hwy., Vara Bldg., Norwood, Mass.
William D. McKinley, '52; November 2, 1981; 56 Harness Ln., Sudbury, Mass.
Douglas G. Harvey, '53; June 14, 1982; 220 Ridgewood Rd., Baltimore, Md.
Alice Schomburg Maher, '53; May 19, 1982; 10909 Olm Dr., Fairfax Station, Va.
Richard A. Nilson, '54; August 13, 1981; 925 Williams Ave., Placentia, Calif.
Stephen T. Fessenden, '55; April 24, 1982; 2 Herold Rd., Peabody, Mass.
Hans Meier, '59; May 14, 1981; Bar Harbor, Me.
Leslie H. Tharp, '62; October 1981; RD 2 Box 864, Cobleskill, N.Y.
Karen Shields, '66; May 5, 1982; Homestead Circle, Old Lyme, Conn.
Richard E. West, '71; June 4, 1979; c/o Mrs. A.W. West, 62 Dalton Rd., Belmont, Mass.
Gordon L. Fulton, '76; July 10, 1982; 7170 Shady Vale Ln., Houston, Tex.
Edward W. Kruppa, '78; May 19, 1982; 15617 SE 43rd St., Bellevue, Wash.
Edward L. Horton, '82; June 26, 1982; 5041 Waters Pl., Shreveport, La.
Russell F. Chihoski, '83; June 13, 1982; 2116 W Davoes Ave., Littleton, Col.

Puzzle Corner
Allan J. Gottlieb

Water In Your Ice Cream Cone



Allan J. Gottlieb, '67, is associate research professor of mathematical sciences at the Courant Institute of Mathematical Sciences, New York University; he studied mathematics at M.I.T. and Brandeis. Send problems, solutions, and comments to him at the Courant Institute, New York University, 251 Mercer Street, New York, N.Y., 10012.

Alice and I want to thank you all once again for kind words concerning our new son. Larry Marden notes a coincidence: "When I began reading your column, I couldn't help feeling that something sounded very familiar. You see, on Sunday evening, March 14, my wife also gave birth to our first child, also a boy, but 'only' weighing 8 lbs. 10½ oz. By the way, I completely agree with all your comments about the delivery process and the participants."

Special note, on a different subject: both chess and (especially) "speed" problems are in short supply.

Problems

OCT 1 We begin with another of Emmet Duffy's seven-card bridge problems. South is on lead with hearts as trump and is to take all tricks against the best defense.

	♠ A J ♥ 5 ♦ K Q ♣ 10 8	
♠ K 2 ♥ — ♦ J 9 8 ♣ 9 7		♠ 4 3 ♥ 6 3 ♦ 7 ♣ 6 5
	♠ Q ♥ 8 4 ♦ A 10 3 2 ♣ —	

OCT 2 Stephen Spacil sent us the following set of cryptarithmetic puzzles created by Nobuyuki Yoshigahara. The set is entitled "Seven and Twelve:"

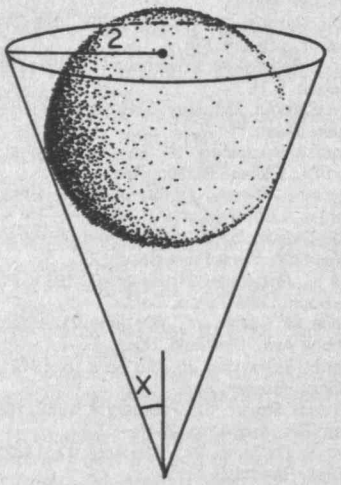
```
  THREE
   SEVEN
   SEVEN
+  SEVEN
-------
 TWELVE×2
```

```
  EIGHT
  EIGHT
   SEVEN
   SEVEN
   SEVEN
+ ELEVEN
--------
 TWELVE×4
```

```
    ONE
   SEVEN
   SEVEN
   SEVEN
   SEVEN
+  SEVEN
-------
 TWELVE×3
```

```
    FIVE
    FIVE
   SEVEN
   SEVEN
   SEVEN
   SEVEN
  ELEVEN
+ ELEVEN
--------
 TWELVE×5
```

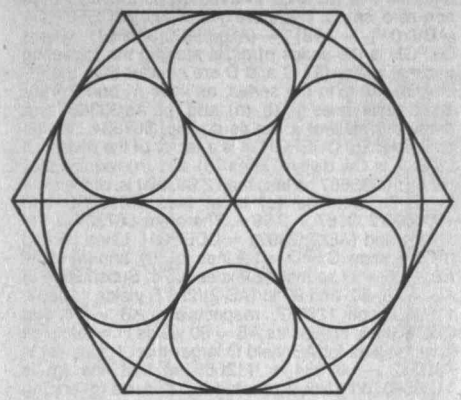
OCT 3 Edmund Nadler likes to fill his ice cream cones with water and spheres. He obviously has a lot to learn. Mr. Nadler writes: Given an ice cream cone filled with water, how large a sphere displaces the most water? Let the half angle of the cone be x, and let the radius of the base be 2.



OCT 4 Reino Hakala wants to know the closed form (not infinite series) solution of $dy/dx = x - y^2$.

OCT 5 Lou Anne Nesta asks:
Given a regular hexagon with an inscribed circle, what is the ratio of the area of the six

smaller circles (see drawing) to the area of the inscribed circle?



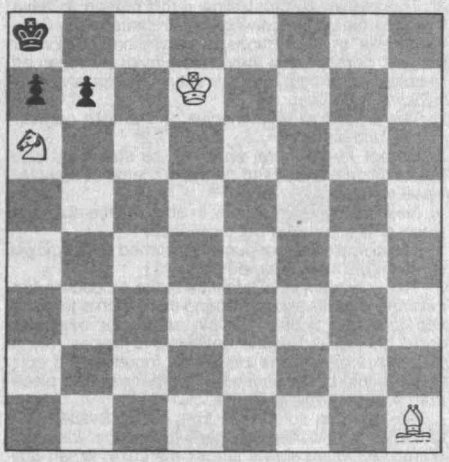
Speed Department

SD1 Lester Steffens suggests:
DAVID × (something) = BENDIX.

SD2 Emmet Duffy wants to know the last three digits of 7^{9999}.

Solutions

M/J 1 Given the positions shown, White is to play and mate in three moves. In the first case, the Black pawns move *up* the board, in the second the Black pawns move *down* the board.



Larry Marden had little trouble with either case in this bidirectional problem: Whether Black moves up or down the board, White must avoid the obvious pitfall of stalemate, to which most of the available moves lead. A little experimentation leads to the following:

Down the board:

White:	*Black:*
B—B6	P × B (forced)
K—B8	P—B4 (forced)
N—B7 (mate)	

Up the board:

White:	*Black:*
K—B6	P—N8 (N) (ch)
K—B7 (ch)	N—B3
B × N (mate)	

or, even easier:

K—B6	P—N8 (R)
K—B7 (mate)	

or, finally:

K—B6	P—N8 (Q or B)
N—B7 (ch)	(Q or B) × N (forced)
K × (Q or B) (mate)	

Also solved by Elliott Roberts, Ed Chang, Martin Wohl, Richard Hess, Raymond Gaillard, David Evans, Rony Adelsman, Michael Jung, Thomas Sico, Dave Simen, Matthew Fountain, and George Sharman.

M/J 2 How many regular decompositions are there of the sphere? (A regular decomposition is one in which the surface is subdivided into congruent spherical regular polygons, where a spherical polygon is called regular if all its vertex angles are equal.)

As Allen Tracht points out, the answer is either five or infinity: There are five regular decompositions based on the five regular solids known to Euclid plus an infinite number composed of lunes. These decompositions are tabulated as follows:

Number and type of spherical polygons	*Number of vertices*	*Vertex angles in degrees*
4 Three-sided	4	120
6 Four-sided	8	120
8 Three-sided	6	90
12 Five-sided	20	120
20 Three-sided	12	72
N Two-sided	2	360/N

Also solved by Richard Hess, Matthew Fountain, and the proposer, Roy Sinclair.

M/J 3 Given an integer $n > 0$ and an odd integer m, prove that any odd integer has one and only one mth root mod 2^n.

Richard Hess begins by showing uniqueness. That is, assume
$2k + 1 \equiv q^m \bmod 2^n$, and
$2k + 1 \equiv p^m \bmod 2^n$.
Then both p and q must be odd, and by subtracting we get
$0 \equiv q^m - p^m \bmod 2^n$. But
$q^m - p^m = (q - p)(q^{m-1} + q^{m-2}p + \ldots + qp^{m-2} + p^{m-1})$,
and the second factor contains an odd number of terms each of which is odd. Thus, the second factor is odd and hence not zero mod 2^m. This shows that $q \equiv p \bmod 2^m$,
so at most one mth root exists. To show that an mth root does exist, Mr. Hess counts: the 2^{n-1} odd numbers $1^m, 3^m, 5^m, \ldots (2^n - 1)^m$ are all distinct mod 2^m as shown above. Thus they must include all the odd numbers from 1 to $2^n - 1$.

Also solved by Dave Simen, Allen Tracht, John Prussing, and the proposer, Alan LaVergne.

M/J 4 Determine the 145 digits in this skeleton division in which each "x" represents one digit. The nine quotient digits shown in bold type form a repeating decimal (i.e., the group as a whole repeats indefinitely). Divisor and dividend have no common factor. Find the digits; there is only one possible answer.

```
xxxxxx  xxxxxxxxx.xxxxxxxxxx
        xxxxxx
        xxxxxxx
         xxxxxx
         xxxxxxx
         xxxxxxx
          xxxxxxx
           xxxxxx
           xxxxxxx
           xxxxxxx
            xxxxxxx
            xxxxxxx
             xxxxxxx
             xxxxxxx
              xxxxxxx
              xxxxxxx
                 xxxxxx
                 xxxxxx
                 xxxxxx
```

Matthew Fountain offers us a step-by-step derivation:

```
667334  7752341      11.6168830001    (a)
        667334   (b)    DEFGH  C
        1079001  (c)
         667334  (d)
         4116670  (e)
         4004004  (f)
          1126660  (g)
           667334  (h)
           4593260  (i)
           4004004  (j)
            5892560  (k)
            5338672  (l)
             5538880  (m)
             5338672  (n)
              2002080  (o)
              2002002  (p)
                  780000  (q)
                  667334  (r)
                  112666  (s)
```

The solution starts with recognition that line (q) begins with two digits, say AB, followed by four zeros, and that line (a) ends in three zeros followed by a non-zero, say C. Therefore (the divisor)(CDEFGH) = (AB)(10^{11}) − (AB) = (AB)(2997)(333667), where DEFGH is the series of digits starting the repeating decimal in line (a). C and D are smaller than the remaining digits in the series, as lines (r) and (h) are shorter than lines (j), (l), (n), and (p). As 333667 is a prime and neither it nor its double, 667334, fits the description of CDEFGH, it is a factor of the divisor. If 333667 is the divisor, lines (d) and (h) require that [line (c)]/333667 be less than 2.93, that is, of the form 2. × 2.. But line (c) is at least 1000000 and 1000000/333667 = 2.99+. Therefore 667334 is the divisor and (AB/2)(2997) = CDEFGH. Lines (r) and (h) now show C = D = 1. Lines (q), (r), and (s) show AB − 66 = xx so that AB exceeds 76. Substitution of AB = 78, 80, and 82 in (AB/2)(2997) yields 116883, 119880, and 122877, respectively. AB = 78 and CDEFGH = 116883 as AB = 80 yields H = 0 and all larger values for AB yield D larger than 1. Line (s) is 780000 − 667334 = 112666 so that line (g) is 1126660. With line (e) ending in 0 and line (g) ending in 60, line (f) must end in 4. Therefore the third digit of the quotient is 6. Lines (b) and (d) contain six digits, showing the first two digits of the quotient are ones. The dividend = (6667334)(11.6168830001..) = 7752341. The rest of the problem is just arithmetic.

Also solved by Edwin McMillan, Richard Hess, Norman Wickstrand, and Dave Simen.

M/J 5 Consider the problem of dividing a cake equally between two people A and B using only a knife. Assuming A and B always try to maximize their shares, the well-known solution is to let A cut the cake into two pieces and B choose one piece. This forces A to cut the cake into pieces as equal in size as possible since otherwise B would choose the bigger piece. What is sought is a procedure for the generalized problem, under similar circumstances, to divide a cake equally among three or more people subject to the following conditions:

1. The procedure must allow *each* person to have the opportunity of receiving his fair share of the cake regardless of the actions of any other person or group of persons who may have previously schemed to obtain more than their fair share of cake and then to divide it up later.
2. The procedure must involve only a finite number of cuts and steps.
3. Except for temporal ordering, no statement can be conditional or depend on the outcome of any previous statement.
4. No statement can specify in any way the size of a piece or pieces to be cut or chosen.
5. The complete procedure is assumed to be known by all before being carried out.
6. The only allowed operations in the procedure are cuts and choices and combining more than one piece into a single piece. Possible steps, for example, could be (1) A cuts the cake into 6 pieces. (2) B chooses 4 pieces and puts them together and cuts the sum into three pieces. (3) C chooses one piece from A and one from C, etc.

The following solution is from David Evans, who attributes it to Martin Gardner's book, *Aha! Insight*: A knife is moved slowly across the cake. When any of the n participants believes that at least 1/n of the cake has been measured off, that person yells "Cut!", the cake is cut, and that person receives the piece and drops out. This reduces n by one, and the process is repeated until n = 2. Now we have the well-known solution mentioned in the problem. This procedure guarantees that each person believes he or she received a fair piece but does not ensure that no one believes that someone else received a bigger piece. No procedure is known that gives this greater assurance for n > 3.

Also solved by Larry Marden, Frank Carbin, Richard Hess, Matthew Fountain, and the proposer, Howard Nicholson.

Better Late Than Never

M/A SD 2 Mary Lindenberg notes that AB should read DB.

Proposers' Solutions to Speed Problems

SD 2 The expansion of 7^4 is 2401. Multiplying 2401 by itself four times, the last three digits become 801, 201, 601, and 001 (adding 400 for each multiplication). Then 7^{20} ends in 001 and also 7 raised to a power which is any multiple of 20, such as 7^{9980}. To get 7^{9996} multiply by 2401 four times and the last three digits become 401, 801, 201, and 601. To get 7^{9999} multiply by 7 three times and the last three digits become 207, 449, and 143—which is the answer.

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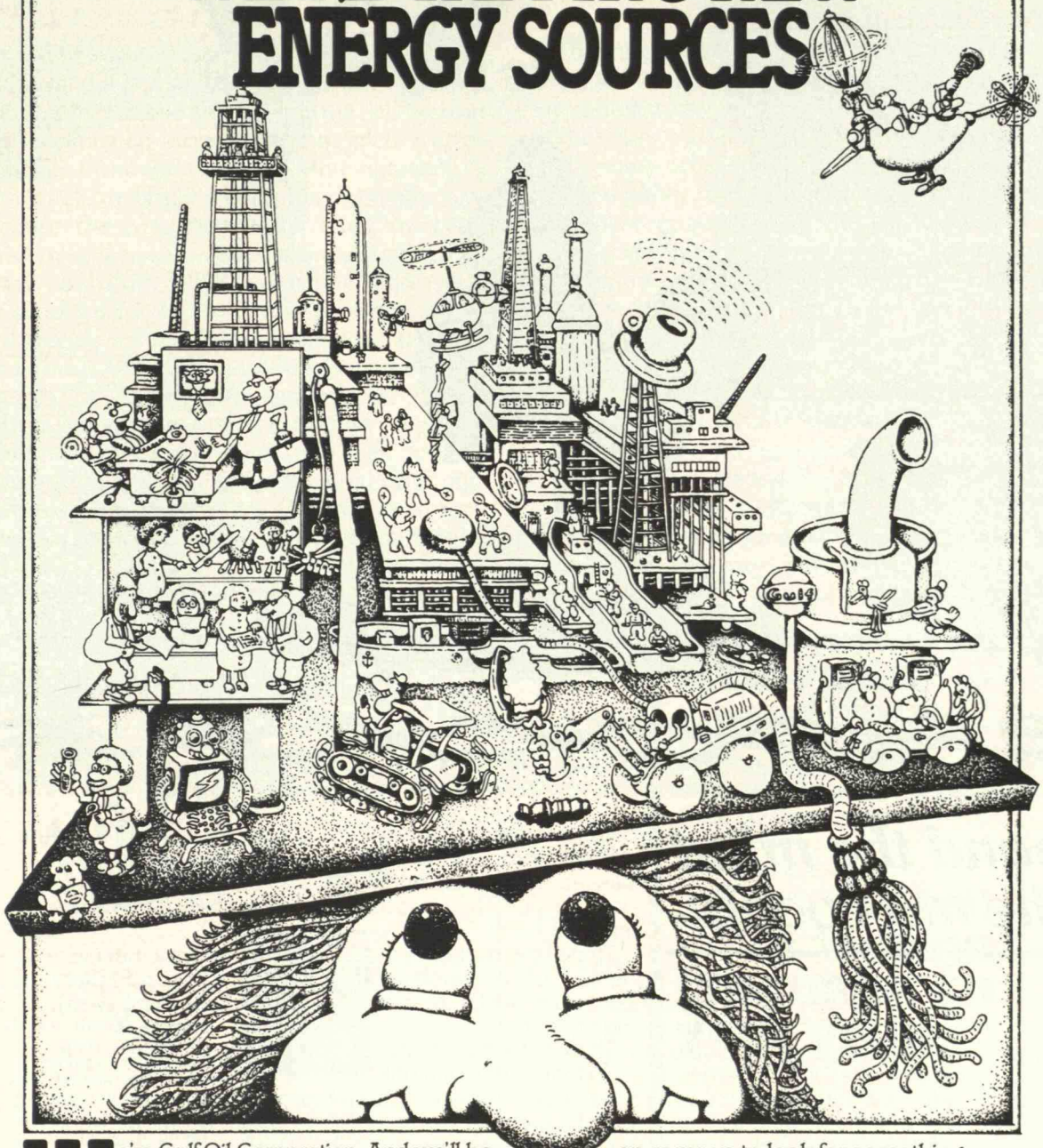

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The most effective strategy may be developing new reactor systems that are more compatible with the utility industry's present structure.

tify the present reactor size. Possibly, but construction cost data do not provide supporting evidence. The doubling of reactor size during the 1970s coincided with spectacular increases in construction costs, so any savings from plant scale-up were obscured. In fact, the switch to larger plants may actually have helped cause the cost escalation. Their increased complexity probably encouraged more exacting regulations and contributed to the startling increases in the time required for licensing and construction experienced during this period. Longer lead times increase the effects of inflation and high interest rates. For example, at current rates, an increase in construction time from 8 to 12 years can add 40 percent to the cost, with interest and inflation then accounting for over 60 percent of the plant's final price tag.

A more radical technological approach is to focus on the cause of the most compelling nightmare about nuclear power: the chance that conventional reactors will be seriously damaged by accidental overheating or melting of the core, and the smaller but still finite chance that such damage will release large amounts of radioactivity into the environment. Estimates of these risks vary, but they are significantly smaller than many other natural and human-made risks facing the public. Nevertheless, reactor safety is at once the most important public concern about nuclear power, the chief driving force for changes in reactor design, and a major contributor to construction cost increases. It is also a key factor shaping utility perceptions of the risks of nuclear investment: Three Mile Island was a vivid reminder to utility executives that light-water reactors are susceptible to accidents that have potentially disastrous financial consequences even if no significant damage is done to public health and safety.

Conventional light-water reactor systems rely heavily on a combination of automated safety systems and operator actions to remove excessive radioactive-decay heat from the core after a malfunc-

Preserving the nuclear option will mean finding ways of making the industry competitive during a lengthy period of low growth.

tion. As a result, upgrading reactor designs to increase safety is essentially an open-ended process; it is always possible to postulate equipment failures, human error, or malevolent actions that can cause major core damage. And since there has been no definite answer to the politically difficult question of "how safe is safe enough?", the pressure to "ratchet up" the design by adding another layer of safety systems is difficult to resist.

However, not all reactor systems rely equally on external safety equipment and human action to prevent core damage. For example, engineers at the Swedish nuclear manufacturing firm of ASEA-ATOM recently devised a reactor concept in which core damage is prevented by the inherent characteristics of the reactor itself. The core is situated in a large pool of pressurized cold water, which in turn is contained in a prestressed concrete pressure vessel. Emergency cooling is activated by the change in water pressure inside the vessel following a malfunction, which automatically forces the cold pool water through the core. The vessel contains enough water to ensure removal of the core's residual heat for several days after shutdown. Any credible threat to the reactor from equipment failure, human error, earthquakes, sabotage or military attack could thus be met without the need for outside intervention by operators or equipment.

The Swedish engineers say this design could compete economically with conventional reactor systems, and that because it relies largely on proven light-water reactor technology it could be ready for commercial operation by the mid-1990s. It is too early to tell whether these claims are justified. But the important point is that when engineers were given the freedom to develop a light-water reactor tailored to current utility needs, the result was quite different from conventional reactors. Other designs, such as the various high-temperature gas-cooled reactor systems under development around the world, are also worth a close look in this regard.

Major obstacles stand in the way of any such technological innovations, however. Developing and testing new reactor systems is expensive, even for designs based on proven technology. Regulatory uncertainties loom large: What would be required to establish a basis for licensing a new reactor, and how long would the process take? Many in the nuclear industry also believe that if they just wait, future growth in electricity demand and problems facing other generating technologies will leave no choice but to return to the nuclear option in roughly its present form—thus removing any need for expensive outlays on reactor development. Finally, after the bitter controversies of the last decade, the present mood of the nuclear industry—both manufacturers and utilities—is to avoid any course that might cast doubt on the wisdom of its commitment to the present technology.

Our Last Chance to Save Nuclear Power?

There is much irony in the transformation of one of the world's most technologically innovative industries of the 1950s and 1960s into the beleaguered, defensive nuclear industry of today. And the irony is heightened by the possibility that further technological innovation could so improve the prospects for its domestic revival. Moreover, not the least of the incentives for U.S. firms to develop new reactor systems is the potential benefit to be reaped in export markets. By the end of the century, industrializing Third World countries are likely to have some of the world's most active nuclear construction programs. Small, simple, and less vulnerable reactors will be especially appropriate to this new market in countries characterized by small electricity grid size, shortage of skilled personnel, and (in an unfortunately large number of cases) risk of military attack on nuclear installations.

If the United States is to mount a serious effort to develop new reactor systems, financial risk-sharing will be paramount. No manufacturer will tackle this job alone. Utilities will have to participate, and government incentives will almost certainly be required. Objections to federal "subsidies" will doubtless be raised, but in industries as fragmented and heavily regulated as the electric utilities, long-term technological development programs are nearly impossible without some form of federal participation.

One possibility involves federal matching funds for manufacturers participating in a preliminary reactor design competition. (Foreign designers could enter through joint ventures with American firms.) Utility representatives would be the judges, since the objective is to translate utility needs into new technology. The winning design (or designs) would be further developed by utility-manufacturer consortia. Other federal support might include special tax incentives for reactor development and various forms of price

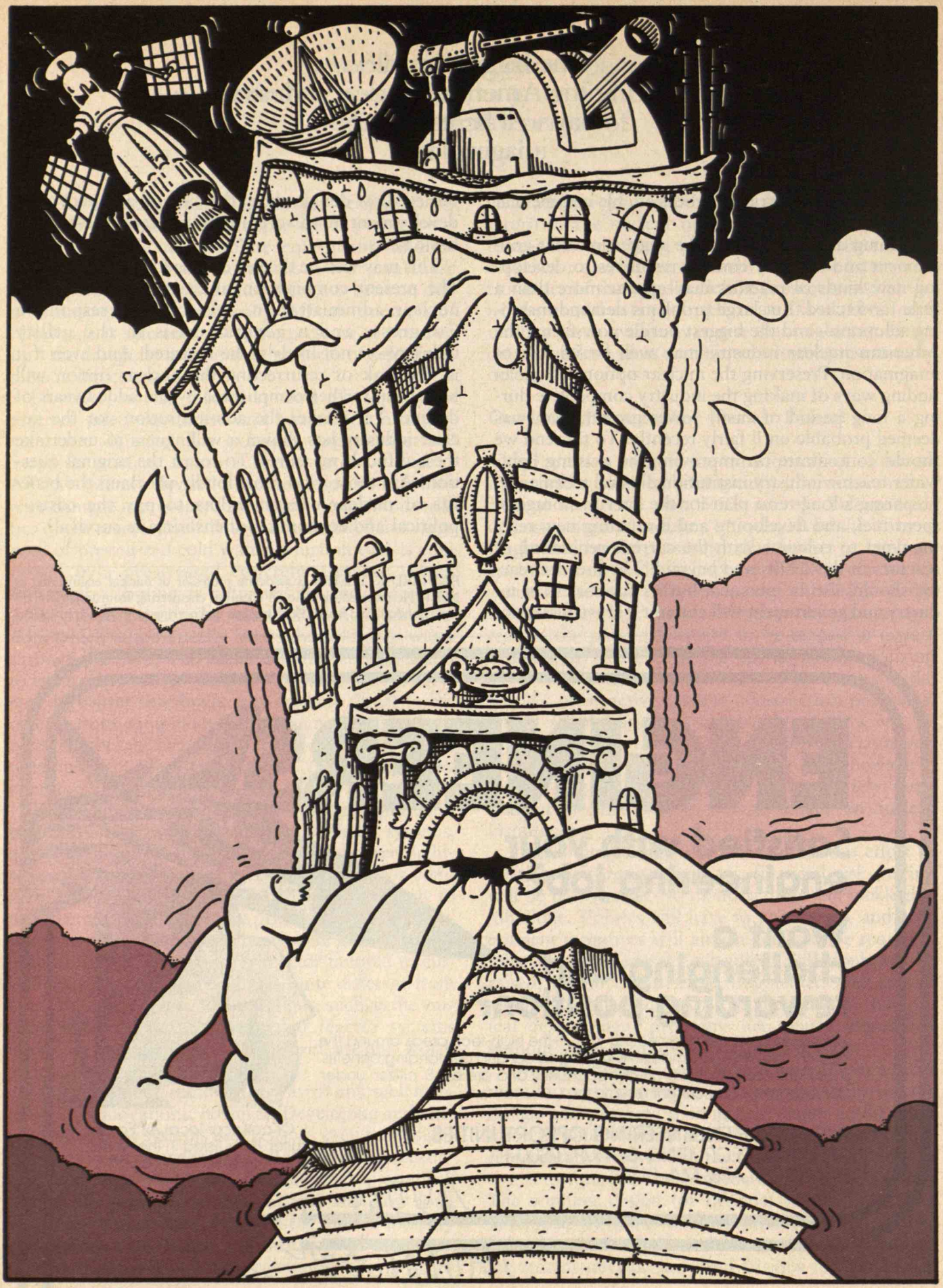
The biggest hurdle now facing the American nuclear industry may well be its loss of imagination.

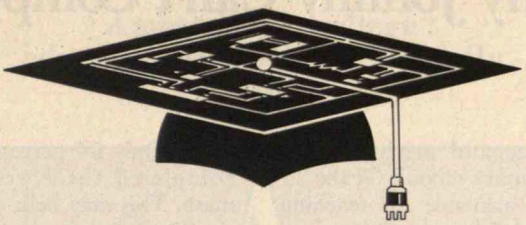
guarantees for electricity produced by commercial prototype reactors.

Coming at this juncture, the suggestion that government and industry commit resources to developing new kinds of reactors may appear more than a little far-fetched. But large problems demand matching solutions—and the biggest hurdle now facing the American nuclear industry may well be its loss of imagination. Preserving the nuclear option will mean finding ways of making the industry competitive during a long period of vastly lower growth than was deemed probable until fairly recently. To this end we should concentrate on improving the existing light-water reactor industry institutionally and technically, preparing a long-term plan for the interim storage of spent fuel, and developing and evaluating new reactor types to compete with the current generation of reactors in the 1990s and beyond. The breeder reactor should also be pursued, but its supporters in industry and government will commit a grave disservice if they allow debate about the method and pace of its development to divert attention from these more basic tasks.

This may well be the last chance for nuclear power. The present combination of circumstances—a pro-nuclear administration, a reasonably responsive Congress, and a general crisis in the utility industry—is not likely to be repeated. And even if it is, the task of resurrecting the nuclear option will have been further complicated by the added years of decline. Yet neither the administration nor the nuclear industry has shown a willingness to undertake these difficult measures. To recast the original question: Are those who most loudly proclaim the benefits of nuclear energy willing to pay the costs—political and economic—of ensuring its survival?

RICHARD K. LESTER is associate professor of nuclear engineering at M.I.T. He received his B.Sc. in chemical engineering from Imperial College, London, and his Ph.D. in nuclear engineering from M.I.T. in 1979.





High Technology, Higher Education, and High Anxiety

BY JAMES BOTKIN, DAN DIMANCESCU, AND RAY STATA

American high technology is a rising star whose future depends on a diminishing resource: the supply of engineers and computer scientists. Yet creative solutions are possible.

HIGH-TECHNOLOGY products and services—such as electronics, computers, and telecommunications—embody an unprecedented amount of human knowledge and technically sophisticated labor. But the importance of the educational system in developing these resources is not widely recognized, especially by government.

Presidents of American universities and other institutions of higher education confirm that the shortage of scientists and engineers—the lifeblood of high-tech companies—is acute. Many engineering classrooms and laboratories are operating beyond their capacity, faculty salaries are not keeping pace with industry rates, and equipment is sadly outdated. High schools and primary schools are graduating children who for the first time are less well-educated than their parents. Not only are reading scores down, but the quality of math and science training is diminishing as teachers leave their profession for better-paying jobs elsewhere.

If analyses of present trends are correct, the discrepancy between the demand for people in high-technology industries—especially electrical engineers and computer scientists (EE/CS)—and those supplied by educational institutions is severe. This mismatch has been building since the early 1970s: the number of people receiving electrical engineering degrees has remained flat despite continuing high demand from industry. Moreover, no significant long-term relief is foreseen. According to studies sponsored by professional societies and industrial associations such as the American Association of Engineering Societies, the National Academy of Engineering, and the American Electronics Association, the EE/CS supply will show no significant increase in the foreseeable future unless dramatic new actions are taken.

According to the Bureau of Labor Statistics, the employment in the electronics industry will grow 2.6 percent each year until 1990. But this figure may be unduly weighted by the slower-growing radio communications sector. If we consider the faster-growing computer and electronics sector as well as the buildup in military procurement, the demand in the 1980s will probably be more like the 1960s, and average more than 5 percent.

But the net growth of the electrical engineering

ILLUSTRATIONS: MICHAEL G. COBB

Why Johnny Can't Compute

by Paul DeHart Hurd

If you know a young person who has recently finished high school, chances are he or she is scientifically and technologically illiterate. The United States seems to be losing ground not only in qualifying its young people for careers in science and engineering, but also in preparing them for contact of almost any kind with the modern world of technology.

The past decade has seen a continuing decline in both the quantity and quality of science and math education. There is a shortage of teachers to correct these deficiencies, and many who do teach are improperly prepared. These concerns become more serious when comparing U.S. programs with those of other countries.

An Acquired Distaste

Let's start with *quantity*. Our children are introduced to science and arithmetic in elementary school. Of the 25 hours available for teaching in a school week, children receive, on the average, one hour of science and less than four of arithmetic. Students continue math in junior high, but most don't start algebra—the first rung on the ladder of higher mathematics—until the ninth grade, and then only two-thirds do so. Science programs fare even less well: most junior high schools offer few opportunities to explore scientific topics in any systematic or cumulative way.

A little over 3 million young people graduate from our high schools each year. Most seniors have had a biology course, a little over a third have had chemistry, but less than a fifth have had three years of science. A traditional physics course is part of this sequence for only 10 percent of high-school graduates. Only 34 percent have completed three years of math. This may help explain the 70 percent increase in remedial math courses offered by public four-year colleges over the last five years.

How does this happen? One clue is student attitudes. The popularity of mathematics drops from a high of 48 percent in grade 3 to a low of 18 percent in grade 12. Science fares worse still, the result of a dislike acquired early. By the end of the third grade, nearly half the students feel they would not like to take more science. Only 20 percent of eighth graders have a positive attitude toward science courses, a percentage that remains constant through high school. One encouraging note is that students like science when they learn about it *outside* school: through museums, planeteriums, "marine worlds," and television.

Scoring Low

What about the *quality* of science and math learning? Three successive nationwide studies showed a decline in science achievement. In two successive national studies of mathematics, elementary school children showed a negligible decline overall, but the decline widened for 13-year-olds and was greatest for 17-year-olds.

In addition, average science and mathematics scores on standardized tests have steadily declined over the past 20 years. The mean score in mathematics on the Scholastic Aptitude Test (SAT) dropped from 502 in 1963 to 466 in 1980. Even the proportion of students scoring above 700 (out of a possible 800) on the SAT mathematics test declined 15 percent between 1967 and 1975. During that time, the number of students scoring below 300

workforce is expected to be only about 1.7 percent per year. This growth is primarily a function of three variables—new supply from colleges (about 7.7 percent of today's workforce), retirements and death (about 1 percent), and exits from the engineering workforce for jobs in management and other careers (estimated at 5 percent).

Projections of a shortfall between supply and demand must be taken with some skepticism. Critics point out that employment predictions are often based on data that are unreliable or difficult to interpret. Professor J. Herbert Hollomon and Dr. Marvin Sirbu of M.I.T., for example, contend that demand for engineers typically moves in short-term cycles of five years or so, and thus is self-correcting. Yet Sirbu admits that "these ideas are based on generalized information about *all* scientists and engineers. We did not attempt to look at subsectors such as electrical engineering or computer science."

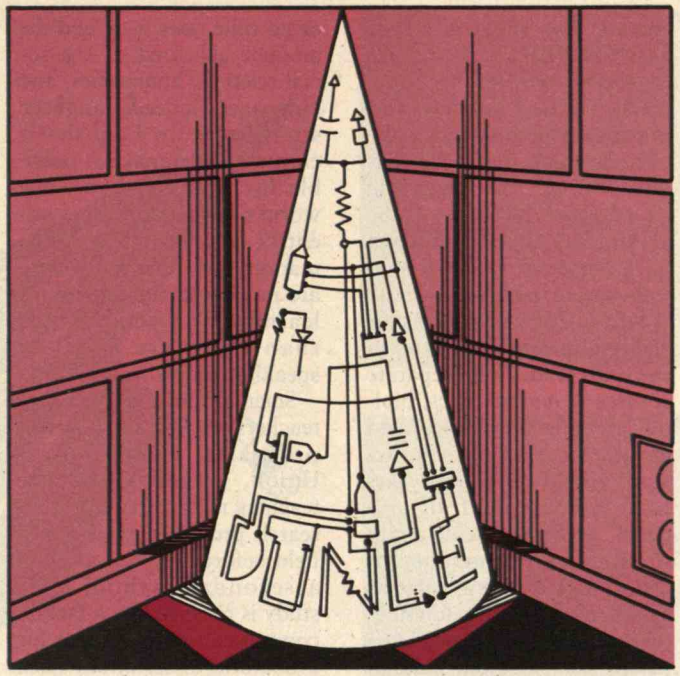
Only time will tell whether today's shortage of electrical engineers and computer scientists will become a glut tomorrow. What is clear, however, is that the technical workforce in America is shrinking compared with those in Japan and Germany, countries which have three to four times more EE/CS graduates on a per capita basis. As the economies of developed nations become more technology-intensive, the battle for international trade could boil down to the quality and quantity of engineers.

Choices for Here and Now

What are our choices for dealing with shortages in the technical workforce? Should we slow the growth of high technology to match the supply of engineers? Increase the numbers of new engineering graduates? Increase the immigration of engineers from abroad? Increase the productivity of engineers in the workforce? All these possibilities will occur to some extent as the gap between supply and demand widens.

Yet even with a concerted effort, it will take three to five years before the size of the existing engineering workforce can be increased with new graduates. Therefore, in the near term, the best alternative is to increase the productivity of the pool of experienced engineering talent. Increasing the productivity of the

American precollege education in science is woefully weak.



on the mathematics section increased 38 percent.

(There is a bright spot in this dismal picture, however. In the 1970s the number of students taking advanced placement-examinations more than doubled, and the mean grades in science and mathematics increased every year from 1969 to 1979.)

Who is doing the teaching? The shortage of qualified mathematics and science teachers is a matter of serious concern in American schools. In 1980, 28 states reported a shortage of math teachers, and 16 states listed the problem as critical. The situation is similar in both general science and science specialties. During the 1970s, the United States experienced a 77 percent decline in the number of secondary-school mathematics teachers being trained, and a 65 percent decline in science teachers. Moreover, of those trained to teach science or mathematics, fewer are going into teaching; many choose industry instead. Nationwide, 50 percent of the teachers employed by high schools to teach math or science for 1981-82 were unqualified; they taught with emergency certificates.

Not only is there a shortage of qualified science and mathematics teachers, there is also a shortage of college programs to educate them. The training of science and math teachers has become nobody's business. And the extensive programs set up by the National Science Foundation during the 1960s to retrain teachers after college no longer exist.

Looking Abroad

Consider precollege science and math education in other countries, such as the Soviet Union, East Germany, the People's Republic of China, and Japan, where the importance of science and technology is widely recognized.

In these countries, the school year averages 240 days; ours is typically 180 days. There, absence from

(Continued on next page)

approximately 200,000 electrical engineers now working in industry by 10 percent would be equivalent to adding 20,000 new engineering graduates—perhaps more. With the powerful new aids to electronic engineering now available, this goal should not be difficult to achieve.

There is also an opportunity to extend the professional life of engineers. Too many maturing engineers leave for better-paying and more influential jobs in management. The status of engineering can be elevated so that more talented people stay in this field to cope with increasingly complex problems.

In the long run, however, nothing can replace increasing support for education. But faculty shortages, capacity problems, and obsolete equipment are matters of grave current concern.

Limited Faculties

According to the American Council on Education, 1,583 teaching positions were vacant in the nation's 244 accredited departments of engineering during the 1980-81 scholastic year. The overall shortage is estimated to be between 10 and 15 percent of the total full-time faculty pool. In EE/CS departments, the shortage reaches 16 percent. While there are few statistically precise measures, Daniel Drucker, president of the American Society of Electrical Engineers and dean of the College of Engineering at the University of Illinois, estimates that nearly 50 percent of the faculty positions in solid-state electronics, computer engineering, and digital systems have not been filled.

One reason for the shortage of engineering faculty is that academic salaries are inadequate. A professor of computer science can earn anywhere from 25 to 100 percent more in industry. For bright young professors, the discrepancy can be even greater, 200 percent or more, when the alternative to teaching is founding a new company.

Market forces are polarizing salaries to such an extent that the option to become a professor is now looking more and more like a financial chastity vow. And the fewer faculty there are, the more onerous is the workload for those that remain. Since student-to-faculty ratios are increasing, the average engineering faculty member has a teaching burden 40 percent

Half of last year's high school math and science teachers were unqualified.

(Continued from page 52)
school is minimal; in the United States, students are absent an average of 20 school days (one month) per year. These countries have a school week of five and a half or six days and a six- to eight-hour school day. U.S. children attend school four to five hours a day, five days a week. In these countries, school vacations are short and dispersed throughout the year to minimize interference with learning; U.S. children have a three-month intellectual hiatus in the summer.

Each of these countries also has a national policy emphasizing the importance of science and mathematics education to economic and cultural progress. We have no national education policy.

As in the United States, children abroad begin instruction in science and arithmetic in elementary school. For the first three years all their subjects are taught by one teacher. Specially trained science and mathematics teachers take over in grade four—the pattern through all remaining grades. Most U.S. elementary-school children have one teacher for all subjects during the first six years.

Specialized study begins for children in other countries in the sixth grade, with separate courses in mathematics, biology, chemistry, physics, and geography. Each course extends over four to six years and is required of *all* students. Students spend about three times the number of class hours on these subjects as even the most science-oriented American students (those who elect four years of science and mathematics in secondary school).

Yet even with this emphasis on math and science, at no time does it exceed the amount allocated to the social sciences, humanities, and languages. Indeed, language study—usually English—is encouraged to make it possible for students to tap the world's largest source of scientific and technical information: *ours*. Currently there are more students and adults learning English in China than there are English-speaking people in the U.S.

Science and mathematics teachers are trained in special programs. In the Soviet Union, precollege science teachers must carry out a research project in their major field before they can teach in a secondary school. The study is reviewed by a faculty committee similar to that for a doctoral dissertation. Each of the four countries provides continuing programs of in-service ("adult") education; local colleges and universities are expected to assume much of this responsibility. Members of the academy of sciences in each country share responsibility for keeping curricular materials up to date.

I do not mean to imply that we should duplicate these efforts. But they do tell us that other countries recognize the importance of science and mathematics, not only in encouraging a large percentage of students to pursue related careers, but in developing a citizenry supportive of scientific endeavors. I am not sure we are doing the same.□

Paul DeHart Hurd is professor of education emeritus at Stanford University. *This article is adapted from a paper presented to the National Convocation on Precollege Education in Mathematics and Science, sponsored by the National Academy of Sciences in May 1982.*

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greater than ten years ago.

The problem, exacerbated by the salary issue, is not only a present shortage but a future one as well. The number of graduate students at the master's and especially the doctoral level is declining. In 1970, 4,150 master's degrees were granted in electrical engineering; by 1980, the number declined to 3,740. But this 10 percent reduction seems small compared with the 40 percent slide—from 873 to 523—in new electrical engineering Ph.D.s over the same ten years. One of the reasons, of course, is economics. When industry is offering generous starting salaries to graduates, it is hard for students to justify staying in school, especially when tuition is high.

An interesting corollary is the dramatic rise in the proportion of foreign students on American college campuses. While the number of U.S. doctoral graduates in aerospace, civil, chemical, electrical, and mechanical engineering declined by about 40 percent between 1972 and 1980, the percentage of foreign students increased steadily. Nearly half the graduates are now foreign citizens, compared with about 25 percent in 1972.

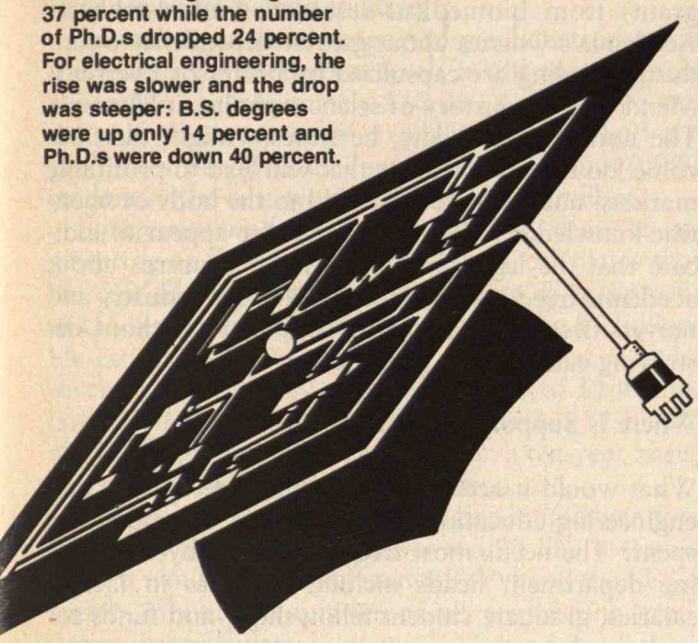
Although some stay in the United States as full-time residents, many others—who wish to stay—find it difficult to obtain work permits from the U.S. Immigration Service. And legislation has been introduced that would require foreign nationals to return home for two years after receiving their degree. This would further undermine an already tight situation. Engineering, like medicine before it, cannot rely on American students alone to meet its domestic needs.

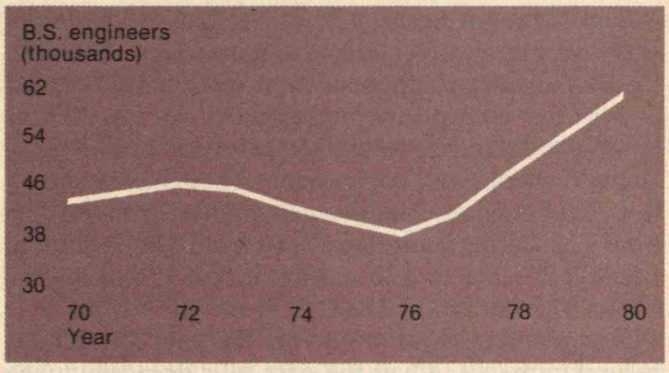
Since most faculty members are drawn from the ranks of doctoral graduates, the ultimate effect of these declines is to reduce the pool of faculty candidates who will train the next generation of researchers. As the number of researchers declines, so do funds to support them, and as funds are withdrawn, research withers further. Although the short-term result is that industry gains while universities lose, industry will lose in the long run if nothing is done to reverse the trend.

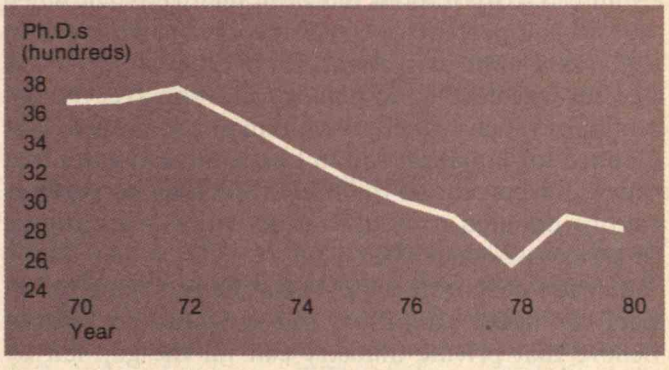
Sources Old and New

The financial plight of the majority of colleges and

Between 1970 and 1980, the number of B.S. degrees awarded in engineering rose 37 percent while the number of Ph.D.s dropped 24 percent. For electrical engineering, the rise was slower and the drop was steeper: B.S. degrees were up only 14 percent and Ph.D.s were down 40 percent.







universities aggravates the problem of producing more engineers. Inflationary pressures have escalated campus costs at rates exceeding budgetary increases. Endowments of private schools have been decimated by inflation and stagnating stock prices, forcing operating losses to be made up from cash gifts that once were a key source of new capital. This means less money for salaries, fellowships, expenses, and laboratory equipment.

It would seem that the United States has been devoting greater resources to higher education. In 1960, the bill for American higher education was $6 billion, in 1970 it was $21 billion, by 1975 it reached $39 billion, and by 1980-81 higher education was a $65 billion enterprise. But the percentage of GNP devoted to education has fallen from a high of 8 percent in 1975 to around 6.9 percent in 1980. Thus, while the number of dollars rises, the net effect is decline.

In the 1980-81 academic year, public institutions accounted for $43.5 billion, or 67 percent of the total expenditures, while private institutions accounted for $21.5 billion, or 33 percent. The largest share of revenue for public institutions comes from state and local governments (51 percent); most money for private colleges and universities comes from tuition (37 percent). Support from the federal government is comparable for each sector—about $4 billion to public and about $3 billion to private institutions. It is these amounts that the Reagan administration plans to trim. While federal support for higher education represents only 10 percent of the total, it is critical for two reasons: it is the major source of funding for research and development, and there are few alternative sources to maintain present levels.

About 80 percent of university R&D is carried out in 100 so-called "leading research universities" that grant more than half of all graduate degrees in science and engineering. They derive almost 70 percent of their R&D funds, and between one-third and one-fifth of their general revenues, from federal sources. Of the $5 billion spent on R&D in science and engineering by all universities in 1979, 66 percent came from Washington. State and local government shouldered only 9 percent of the university R&D bill. Less than $200 million, or 3.7 percent, came from industry.

CHARTS: OMNIGRAPHICS

The option to become a professor is looking more and more like a financial chastity vow.

The National Science Foundation (NSF) is especially crucial to science and engineering education. Under the Carter administration, NSF had budgeted programs to update equipment in university laboratories and to establish new doctoral fellowships in science and engineering. These have been all but eliminated by the Reagan administration. The NSF's education budget declined from $70 million in fiscal year 1981 to $20 million in 1982, and will be about $15 million in 1983.

Can private corporations fill the gaps created by federal cutbacks? Over the past four decades, giving by all U.S. corporations has been relatively flat, when viewed as a percentage of net income before taxes. In 1981 that sum was about $3 billion, of which 25 percent was devoted to higher education. Yet the potential of much higher giving remains untapped. The Council for Financial Aid to Education estimates that only 23.4 percent of the nation's 2.5 million corporations donated to nonprofit activities—educational or otherwise—in 1981.

Greater corporate support can have a positive impact on higher education, but it would be folly to believe that private industry can fill the gap left by federal cuts. At the current rate of $725 million, even a doubling of corporate giving would not make up for a mere 10 percent cutback in federal support.

Where corporate support can make a difference—even though it will still have to be leveraged by government funds—is in selected slices of the higher-education enterprise. Engineering education, for obvious reasons, is of greatest interest to high-technology companies, and engineering education may have a comparatively bright future if corporate contributions are forthcoming. Given that engineers represent 7 percent of graduates, then the overall cost of engineering education is estimated to be 7 percent of the higher education total, or about $4 billion per year. If the high-tech industries contributed 2 percent of their R&D budgets (as proposed by the American Electronics Association), then an additional $400 million might be available—a potential increase of 10 percent in engineering educational capacity.

Industry financing, though attractive, can still be controversial on campus. Recent proposals for new ventures have generated a number of disagreements: at M.I.T. over the semiautonomous $125 million Whitehead Institute for bioresearch, at Wesleyan University over its speculative activities (the sale of one corporation grossed $100 million for the university), at Harvard University over Monsanto's purchase of patent rights (financed by a $23 million grant) from biomedical research, and elsewhere. Academia's worries about greater dependence on industry funding are capsulized by Professor Everret I. Mendelsohn, a history of science scholar at Harvard. The university mandate, he states, "might then become 'do research in areas that will lead to profitable markets, not just those that add to the body of scientific knowledge'." But events thus far appear to indicate that the legitimate and serious concerns about academic freedom can be satisfied—that industry and universities can be mutually supportive without destroying each other's purpose.

Where Is Support Needed?

What would it actually cost to upgrade and expand engineering education? Where would the money be spent? The needs most frequently cited by engineering department heads include increases in faculty salaries, graduate student fellowships, and funds for updating laboratory equipment.

Faculty salaries. Based on 1979-80 rates and an academic year of nine months, salaries range from $12,000 for an instructor to $45,000 for a department head. The national averages are $28,000 for an engineering department head, $26,500 for a tenured professor, $21,000 for an associate professor, $18,000 for an assistant professor, and $14,000 for an instructor. The overall average for full-time faculty is $25,000—about the same that industry will offer the professor's students as a starting salary.

Approximately 20,000 full-time teachers of engineering were budgeted in 1980. There are also some 1,600 job openings for full-time engineering faculty, or about 10 percent of the total pool. The cost of filling 1,600 vacant positions, at an average salary of $25,000, would be $40 million. Giving the entire national engineering faculty a 30 percent raise to make academic salaries more competitive with industry would cost $150 million. This total of $190 million is equivalent to six and a-half hours of expenditures by the Department of Defense.

Graduate fellowships. The long period of graduate study is probably one of the greatest deterrents to becoming a professor. During this time, income is only about one-third what the student could earn in industry. Over the past decade, the median monthly starting salary in industry has risen from $900 to

It would be folly to believe that private industry can fill the gap left by federal cuts.

$2,000, but teaching-assistant fellowships have gone from $300 to only $750, putting the university more than ten years behind industry.

Extending financial support to graduate students at the master's and doctoral levels might entail annual stipends of approximately $10,000 per year per student. If this were made available, say, to half the graduates enrolled in engineering—about 10,000 students—the cost would come to $100 million.

Equipment update. Daniel Drucker, dean of engineering at the University of Illinois, calculates that the cost of a crash program to update all equipment in U.S. engineering departments would be $1 billion. He estimates the useful life of the equipment to be seven years, yielding a per-year figure of $140 million. (Drucker also estimates that there is a $1 billion need for new buildings. Pro-rated on a ten-year basis, this would add another $100 million.)

These estimates are for all engineering education. But many high-tech executives would like to know what it would cost to substantially expand the EE/CS supply (about one-quarter of all engineering graduates) in particular.

One recent estimate of the cost to expand the number of university researchers was made by the Computer Science Board in their "Snowbird Report" of July 1980:

"Assuming the average Ph.D. student spends four years in the Ph.D. program, an average of 1,000 must be in the current pipeline to achieve a graduation rate of 250 per year. Counting 840 Ph.D. computer science faculty, we estimate 1,840 university researchers. If each is capitalized at the average of $30K, the total capital investment would be $55.2M.

"For a different estimate, suppose that the top 200 faculty supervise 400 graduate students using frontier facilities capitalized at $70K per researcher; these 600 researchers require an investment of $42M. Capitalizing the remaining 1,240 researchers at the average of $30K each requires an additional $37.2M. The total investment in this case is $79.2M.

"The above figures show the investment for the current number of researchers. Growth of 50 percent in the number of Ph.D. students would increase the required investment to about $95M."

Another way to estimate the costs of expanding the number of EE/CS graduates is to calculate the cost of an additional faculty member. The Engineering Education & Accreditation Committee of the engineer's Council for Professional Development did so: Assume salary of $30,000, equipment costs of $10,000 per year over 7 years, 1,400 square feet of office space at $12,000 per year over 15 years, and curricular costs of $27,000 per person. This yields a total of about $80,000 per faculty member, and university overhead could easily bring this figure closer to $125,000. At that rate, adding a thousand new faculty members nationwide would cost $125 million a year.

These estimates, it turns out, are not excessively large compared with the total yearly investment of $65 billion in higher education, and they are dwarfed by projected expenditures of more than $200 billion yearly earmarked for defense. Considering the potential payoffs for the economy, a relatively modest set of "targeted" investments in education could be truly cost-effective.

A High-Technology Morrill Act

More than a century ago Justin Morrill, a representative from Vermont, sponsored the Land-Grant College Act ("Morrill Act"), to found colleges to "teach such branches of learning as are related to agriculture and the mechanic arts." This led to establishing the agricultural extension programs and the growth of modern farming in the United States. Today America leads the world in agricultural exports, not only because its land is rich and fertile, but also because the Morrill Act fused the interests of government, education, and the farming community into a national policy for growth. This act is a compelling model for the future of American high technology.

As part of the Morrill Act, the federal government allocated 17,430,000 acres of land to subsidize the founding of a system of colleges. These institutions were to make judicious use of revenues from the land to support their programs. To this day, the land-grant college system remains the cornerstone of agriculture in the United States. It came into being at a time when industrial methods were beginning to revolutionize the farm, and it helped sustain a momentous new productivity in American agriculture.

But perhaps the most impressive legacy of the Morrill Act was the understanding that education—open to all and focused on practical economic needs—could not be divorced from economic growth. Education became a matter of national priority to which the federal government would devote its resources. It was a milestone in turning the

Less Talk, More Action for Engineering Education

by Henry Petroski

In September 1981 the Exxon Education Foundation announced that it had chosen a dramatic way to observe Exxon's centennial. The company would award 100 teaching fellowships and 100 grants to supplement junior-faculty salaries over a five-year period to 66 engineering schools. The total package amounted to $15 million.

An even greater value of the Exxon grant may be the attention it drew to the financial problems of engineering education. Although its graduates are commanding record starting salaries—often higher than those of the faculty who counsel seniors in choosing among a surfeit of job offers—engineering schools themselves are in dire need of new classrooms, laboratory equipment, and faculty members.

The faculty shortage is especially acute: there are approximately 1,600 unfilled engineering teaching positions nationwide. Unlike the situation in the mid-1970s, when hundreds of resumes were sent in response to a single ad, numerous announcements of a faculty opening must now be disseminated to yield a single good curriculum vitae.

The paucity of suitable applicants for faculty positions reflects the condition of American graduate programs in engineering—applicants for junior faculty positions are traditionally doctoral candidates, for whom the end of the dissertation is in sight. While as many as six or seven applicants are turned away for every freshman engineering student who enrolls, graduate schools are having a hard time keeping their classrooms filled.

As long as industry is tempting engineering seniors with lucrative job offers, it is hard for them to opt for the grind of three or four years—or more—of graduate study to earn the Ph.D. necessary for a teaching career. But, as Exxon stated in announcing its grant, "If engineering education suffers, Exxon will suffer sooner or later."

But multi-million-dollar grants, appreciated as they are, may not be the most enduring solution to the problem. Fellowships usually give students a carte blanche to pursue a degree with all deliberate speed. Outside formal coursework, they often have minimal contact with the faculty and dispatch their dissertation much like a final super-course. This ill-prepares them for today's academic world, which seldom allows the luxury of single-mindedness—to survive, one is expected not only to teach but also to secure research funds in a most competitive market.

The portion of the Exxon grant that will pamper 100 fellows for three years may produce a few dozen survivors who go into academic engineering, but this same money might also have been used to permanently endow 30 or so research assistantships. The same number of Ph.D.s would be produced at a slower rate but with academic savvy. These engineers might graduate not only with degrees but with academically advanced research programs readily transplanted to other universities. And as they moved on, the endowment would remain to train the next generation of graduate students.

Such "dedicated" research assistantships, each created

United States away from a legacy of European educational philosophies founded upon mastery of the classics.

A "High-Technology Morrill Act" would forge a new partnership among federal, state, local, and private interests. The act would authorize matching grants for nonfederal initiatives—not just from state governments but also from high-technology industries. Accordingly, industry and universities working together would play a major role in determining where investments in education should be made. Industrial contributions would stimulate grants, in accordance with some formula, from both state and federal governments.

Suppose annual matching funds were based on a 5-3-2 formula: 5 federal dollars for every 3 state dollars and every 2 industry dollars. For example, if $1 billion were earmarked for engineering education, $500,000,000 would come from the federal government, $300,000,000 from the states, and $200,000,000 from industry.

Unlike the 1862 Morrill Act, which sought to establish new educational institutions throughout the nation, the High-Technology Morrill Act would sustain and strengthen existing institutions. To bias the grant process toward high-growth "sunrise" industries, the government could match donors' funds only when they exceed the donations of prior years.

Another precedent of the Morrill Act was the vision of education as a lifelong endeavor. The agricultural research stations established at selected land-grant institutions undertook not only to push research to new frontiers but to continually educate the farmer. Ironically, more than one-hundred years later, the concept of adult education—except in agriculture—is still underdeveloped at most educational institutions. Yet there is no reason why the approach couldn't be adapted to the fast-changing needs of high-technology professionals.

More Government in the Right Places

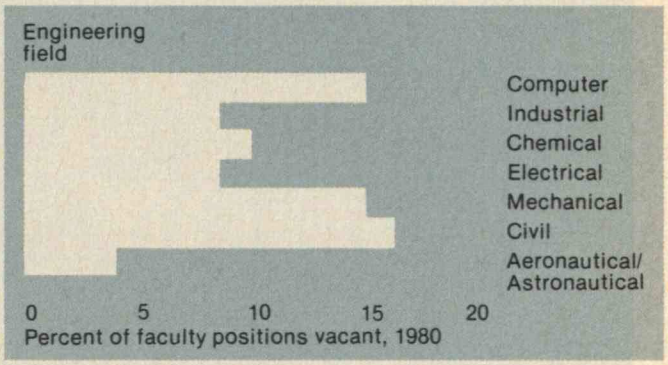
A national strategy must begin with an unabashed commitment by the president of the United States. He must strengthen his science and technology advisory structure, in part by setting up a Presidential Com-

with $150,000 or so, pay dividends not only to the host university but also to the donor, by interesting bright young minds in some of industry's most enduring problems. Properly publicized, specialized research assistantships might even persuade some bright young engineers to forego routine industrial positions for challenging "jobs" in graduate schools. Innovative graduate programs might feature "hybrid" strategies: the prestige of a fellowship for the first academic year and the balance of a graduate education with a research assistantship that, with time, might become equally prestigious.

Dedicating a permanent research assistantship to a particular area could have beneficial effects not only for the graduate student and the company but also for the graduate program. If the endowment were increased to approximately $200,000, underpaid young faculty members could count on one or two months' summer salary to give the research programs continuity. By becoming more intimately involved with the technical details of students' problem areas, those faculty members could better bridge the gap of experience between generations of students.

Endowing a research assistantship will not garner the press coverage of a $15 million grant, but it is a good investment. Even though the corporation would do best not to require research on specific topics within a broad area of interest, ideas on the frontiers of a field will be natural topics of informal discussion. Professors will be an invaluable source of current thinking in the field, and the graduate students will be a prime source of recruits. Whether or not the students actually solve pressing problems in the industry, they will certainly be well prepared to tackle them upon graduation.

Such innovative funding of engineering education could, over a decade or so, have a profound effect on graduate programs and hence on the technological health of the nation.□



The shortage of qualified faculty means many open positions unfilled. During the 1980-81 academic year, 1,583 such positions were vacant in the 244 accredited engineering departments across the United States.

Henry Petroski, a frequent contributor to Technology Review, *is associate professor and director of graduate studies in civil and environmental engineering at Duke University.*

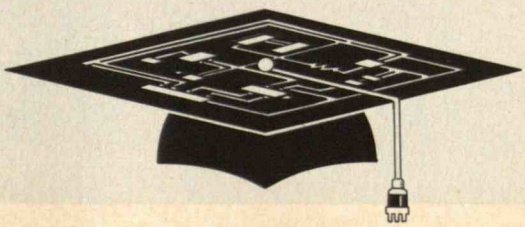
mission on Technology and Productivity. Such a group, in the words of the National Governors' Association, would "serve as the deliberative body responsible for science and technology policy, [ensuring] that those processes, public and private, essential to realizing the benefits of science are [achieved]. The group would define goals and objectives germane to U.S. society, but the analogy is the deliberate decision by Japan to take extraordinary measures for the promotion of the electronics industry.' "

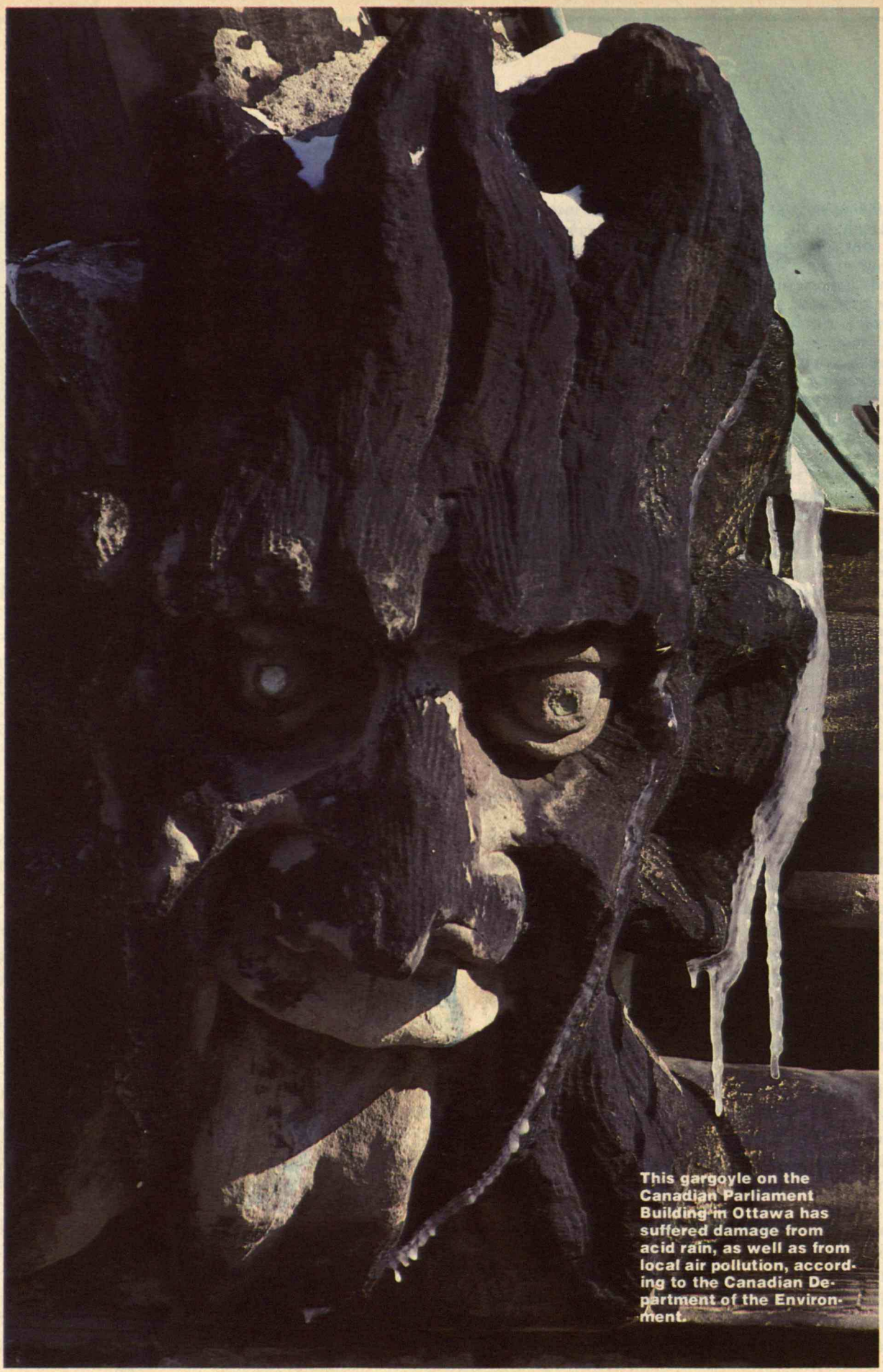
But a fundamental aspect of national policy rests with Congress. A High-Technology Morrill Act would create a long-term funding mechanism for science education and restore it as a national priority (as during the few short years after the *Sputnik* scare of 1957).

The forces for change must be initiated by those most knowledgeable and directly involved. These include the high-technology industry itself, as well as universities that have a vested interest in education in science and technology. But they also include state governments concerned about the future employment of their citizens. Together, state governments can have the greatest effect on higher education and university research. But with few exceptions, they have failed to exercise this power.

A bottom-up approach for strengthening our system of education, stemming up from the constituencies most directly affected, makes a great deal of sense. But these efforts cannot be successful without a coherent national policy. To coordinate state, local, industrial, and academic concerns, federal leadership is crucial.

JAMES W. BOTKIN and DAN DIMANCESCU are consultants and writers on technology policy. RAY STATA is the president of Analog Devices, Inc. and the founder of the Massachusetts High Technology Council. This article is adapted from their book, *Global Stakes: The Future of High Technology in America,* published in September by Ballinger Press (Cambridge, Mass.).





This gargoyle on the Canadian Parliament Building in Ottawa has suffered damage from acid rain, as well as from local air pollution, according to the Canadian Department of the Environment.

What to Do About Acid Rain

BY EVILLE GORHAM

Industry and the EPA say the complex problem of acid rain is still too little understood to warrant undertaking multibillion-dollar cleanup programs. But the evidence calls for action now.

Most acid rain begins when people burn coal, oil, and other fossil fuels or smelt ores to produce metals such as copper and nickel. Among the polluting gases that escape are sulfur dioxide and nitrogen oxides. As these blow downwind, they are transformed in the atmosphere to long-range environmental problems in the form of sulfuric and nitric acids. Their return to lakes and streams, forests and fields, is called "acid deposition," for they can fall along with the rain and snow, but also in dry microscopic particles or gases.

Many other substances also come from the skies in acid rain: some relatively unimportant weak acids; toxic metals including lead, cadmium, and mercury; and organic pollutants such as alkanes, polychlorinated biphenyls, and polycyclic aromatic hydrocarbons, some of which are known carcinogens. Substantial amounts of plant nutrients, such as nitrogen, sulfur, potassium, and calcium, may also fall in acid rain, but this is hardly the way to apply fertilizer.

Serious public concern about the acid-rain problem arose ten or fifteen years ago, but acid rain may have begun as early as the seventeenth century. Sulfur pollution had become serious in London, as evidenced by John Evelyn's diatribe against "smoake" in 1666 in his book *Fumifugium*. In 1852, the scientist Angus Smith discovered acid rain in and around the manufacturing city of Manchester in northern England. And deposits of sulfate, a common end product of sulfur pollution, have increased in the Greenland icecap since the beginning of the industrial age.

But acid rain probably began to spread in earnest over broad rural regions and across international boundaries during this century, especially since World War II. This spread was first documented in 1955, when the team of Earl Barrett and Gunnar Brodin found acid rain in rural Scandinavia, Henry Houghton found acid fog and cloud water in New England, and I observed acid rain in the English Lake District whenever the wind blew from urban, industrial areas. In 1968 in Sweden, Svante Odén showed acid rain to be a major international problem.

During the last several decades, increasing fossil-fuel combustion in western Europe and the northeastern United States, especially by power plants, has severely polluted local air. The solution has often been to construct much taller smokestacks of up to 1250 feet to disperse the emissions. Unfortunately, this allows pollutants to create problems on a broader geographical scale. At the same time, pollution-control devices called electrostatic precipitators have come into use to remove the ash from the emissions. But because ash is alkaline, removing it makes the acids stronger.

Today acid rain may be getting worse. Unfortunately, researchers don't have enough information to decide this question, because methods of collecting and analyzing acid deposition have changed, and collection sites have shifted. However, the acidity of precipitation at a number of stations in Scandinavia

In the Smoking Hills in Canada, where natural fires in exposed coal beds release sulfur oxides, ponds are as acid as lemon juice.

appears to have increased over the last 20 years, and three surveys conducted during the 1950s, 1960s, and 1970s in the eastern United States have suggested that acidity is increasing and spreading more widely. Even if acid rain is not getting worse, it is already a clear danger, especially to lakes and streams.

Tracing the Acid to Its Sources

Even strong acid in precipitation can arise from natural sources. In 1939 Ottaviano Bottini found hydrochloric acid in the rain around Mt. Vesuvius in Italy—an acid that can only have come from the mountain's volcano. Indeed, the rain was very acid—with a pH as low as 2.8, comparable to vinegar. (Acidity is measured on a pH scale: 7 is neutral, and as pH drops, acidity rises exponentially, so that a liquid with a pH of 5 is ten times as acid as one with a pH of 6. Carbon dioxide in the atmosphere dissolves in pure water and produces a weak carbonic acid with a pH of 5.6; anything lower than this is considered acid rain.)

In 1979 Thomas Hutchinson and his associates reported acid deposition on the Smoking Hills in arctic Canada. There, natural fires in exposed beds of lignite coal generate large amounts of sulfur oxides that are converted in the atmosphere to sulfuric acid. Nearby ponds had extremely high sulfuric acid concentrations, with pH values down to 1.8—comparable to lemon juice.

Coastal mudflats and salt marshes may also be natural sources of acid deposition. They release gases containing sulfur that may react in the atmosphere to produce sulfuric acid. Although this effect needs more study, mudflats and marshes are probably not a major source of acid emissions. For one thing, rain at coastal stations in the United States is not strongly acidic. And while sodium and chloride ions in rain from sea spray decline strikingly as one leaves the coast, the hydrogen and sulfate ions that make up sulfuric acid do not similarly decline—making it unlikely that they are generated in large amounts by the shore. Mudflats and marshes may also release ammonia, which helps neutralize some of the sulfuric acid.

In any case, industry and transportation are the major sources of acid deposition. Most of the sulfur oxides come from electric utilities; industries burning fuel or smelting metallic ores containing sulfide are also important. Nitrogen oxides come mainly from automobiles and the utilities.

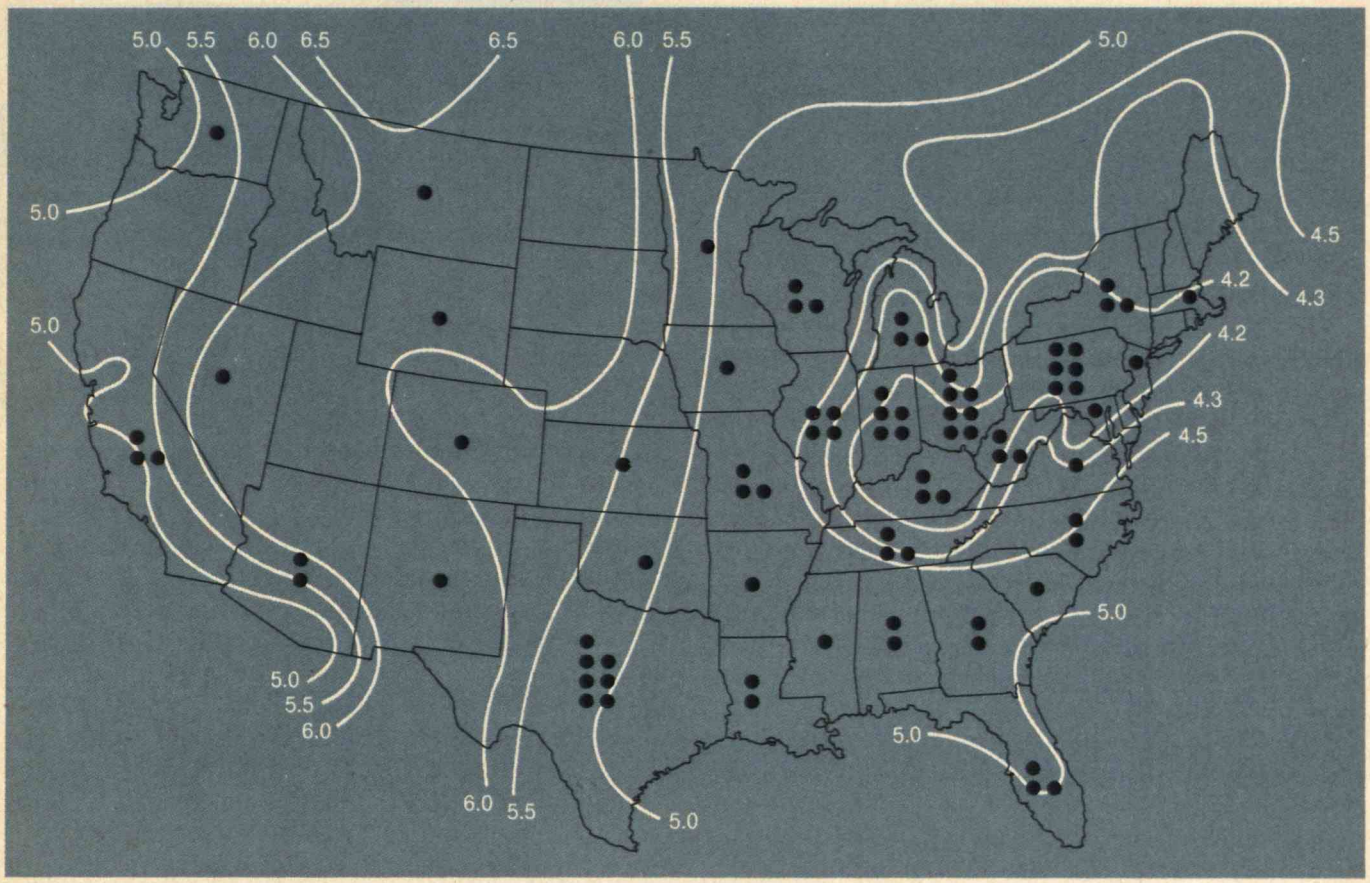
As these gases travel downwind and slowly react with the atmosphere to produce sulfuric and nitric acids, they pollute not only local but far-distant regions. During their travel over hundreds of kilometers, the acids may be wholly or partially neutralized—for example, by dust from cement plants, wind-blown particles of cultivated soil, and ammonia from animal manure. All these neutralizing materials create problems of their own, so they are not a potential solution to acid rain, but they do complicate attempts to trace the acid rain to its source.

The source is easiest to trace when the acid rain falls close by, as does the natural hydrochloric acid rain near Vesuvius or the natural sulfuric acid rain near the Smoking Hills. Angus Smith and the later team of Crowther and Ruston found that rain acidity decreased sharply the farther one got from Manchester and Leeds in England; emissions from coal burning clearly caused this urban acid rain.

An equally convincing case can be made for the area northeast of the iron-sintering plant at Wawa on the northeast shore of Lake Superior. The pH of lakes in that region, normally between 6 and 7, declines to the extremely acid value of 3.2 close to the sintering plant. There are naturally acid bog lakes in the region—some further acidified by emissions from the sintering plant—but they can be distinguished readily by their brown tea color.

The acidity of the lakes near the sintering plant can be traced to it in another way. The acidity of any solution is measured by the concentration of positive hydrogen ions. In the case of sulfuric acid, these are balanced by negatively charged sulfate ions, while in the case of nitric acid they are balanced by negatively charged nitrate ions. In the lakes near the sintering plant, not only are the positive hydrogen ions concentrated to produce high acidity, but the sulfate ions increase tenfold. These can only have come from the sulfur dioxide in the plant, as it combines with oxygen in the atmosphere.

It may still be possible to trace rain acids clearly even at considerable distance from their sources. In the English Lake District the rain is acid, high in sulfates, and sooty when the wind blows from the south and east, the direction of the major industrial districts. In contrast, when the wind blows from the Irish Sea to the west, the rains are clean, lower in acidity, and rich in sea salt. On a broader scale in



Where sulfur and nitrogen oxides are emitted and the resulting acidity of the rain. Each dot represents 500 metric kilotons of emissions. The contours show that acidity inceases in regions near and downwind of the heaviest emissions. (U.S.-Canada Memorandum of Intent on Transboundary Air Pollution and the U.S. Department of Energy.)

England, bog pools with naturally acid, tea-colored waters fed wholly by precipitation become more acid as one travels from remote areas toward the major northern industrial centers. In the remote bog pools pH values are usually around 4.5, whereas closer to the industrial areas acidity increases to a pH of 3.9, and even to 3.2 immediately outside the industrial city of Sheffield.

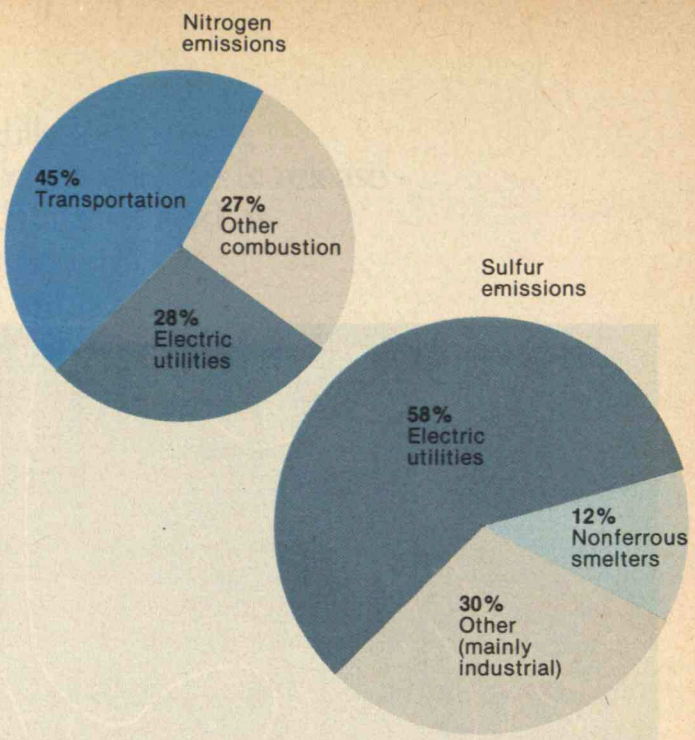
In the United States the area of heaviest acid precipitation—as well as the heaviest deposition of toxic heavy metals—is in and downwind of the chief coal-using states of Ohio, Indiana, and Illinois. These states produce about one-quarter of total U.S. sulfur-oxide emissions and one-sixth of nitrogen-oxide emissions. The only credible reason for the severity of acid rain in this area is the abundance of urban, industrial emission sources in these and nearby states. Unfortunately, the large number of sources creates a pool of acid air pollution over the whole northeastern part of the continent that makes it impossible to trace damage at an individual site to an individual source.

Order from Complexity

Because some cases are even less clear, industry sometimes argues that acid rain comes from natural sources. For example, in Nova Scotia the acidity of precipitation does decline from the southwest—which is near the urban, industrial sources of sulfur and nitrogen oxides in New England—to the remote northeastern parts of the province. However, the numbers of hydrogen ions are not closely correlated with the numbers of either sulfate or nitrate ions. This is presumably because diverse sources of sulfur and nitrogen emissions interact with equally diverse sources of neutralization. For example, calcium or ammonium ions from soil or manure might replace the hydrogen ions in sulfuric acid to produce calcium or ammonium sulfate. The sulfate ions would remain but the hydrogen would not, so the original correlation would disappear.

There is also evidence that rain in North Dakota is partially neutralized. In samples taken in 1978 and 1979, North Dakota agricultural areas had less acid

MAP: OMNIGRAPHICS



Where sulfur and nitrogen pollution in the U.S. and Canada comes from. Most of the sulfur dioxide (SO_2) comes from electric utilities, smelting, and other industries. Nitrogen oxides (NO_X) are largely from automobiles and other vehicles. About 25 percent less nitrogen than sulfur is emitted, and since much of the nitrogen is taken up by plants as a nutrient, it has an even smaller effect.

precipitation than forested areas to the east in Minnesota. The concentration of hydrogen ions was not clearly related either to sulfate or nitrate ions in either place. This was probably because the acids were partially neutralized by windblown soil high in lime and ammonia gas from the North Dakota farmlands. Indeed, melted snow from the Dakotas after blizzards is sometimes so contaminated with blown soil that it is alkaline, with a pH of 8.

But the neutralizing effect of ammonia may be only temporary. At first ammonia combines with some of the sulfate in the atmosphere, producing less acid ammonium sulfate. But after this falls to the ground, plants take up the ammonium ions as nutrient, in exchange for hydrogen ions deposited by their roots, and reconstitute sulfuric acid. Farmers have long known that if they fertilize with ammonium sulfate, they must lime their soils.

Not only is acid rain blown by winds and neutralized by various elements in unpredictable ways; when it actually reaches lands and waters, it can produce many different results. It is most harmful when it falls on streams and lakes on coarse, sandy soils low in neutralizing lime—especially when the watersheds have large areas of exposed granite, quartzite, or other bedrock that itself lacks calcium carbonate, the chief ingredient of lime. Sulfuric acid is particularly dangerous, while nitric acid is probably less so because it is taken up by plants as a nutrient and becomes part of the biomass. However, when the acid snowpack melts in spring and flows over frozen ground to lakes, causing especially severe acidification, nitric acid may well be harmful.

Local conditions vary so greatly that neighboring lakes may become acidified at quite different rates. For example, three lakes close together in the Adirondacks have very different acidities, according to a study by the Electric Power Research Institute. This is because the lakes' drainage basins have different sizes, slopes, and depths of soil. Panther Lake is essentially neutral, except during snowmelt, because the surrounding soils are deep and buffer the acid. Sagamore Lake is moderately acid, while Woods Lake is strongly acid all year long because it has a steep drainage basin, where the buffering capacity of the shallow soils has been severely depleted. Even the biology within lakes affects their acidity: plant photosynthesis and microbes reduce acidity, and plants absorb nitrate and to a lesser degree sulfate as nutrients.

A few scientists have even suggested that it is not acid deposition but changes in forestry practices such as lumbering that have turned lakes acid in recent decades. But local conditions do not appear to have had a major effect on the present widespread problem. Acidification has occurred even above the treeline in Scandinavia and in other places where forests have remained unchanged. Conversely, acidification has not occurred in unpolluted areas where land use has changed, such as in Finland, northern Minnesota, and northwestern Ontario.

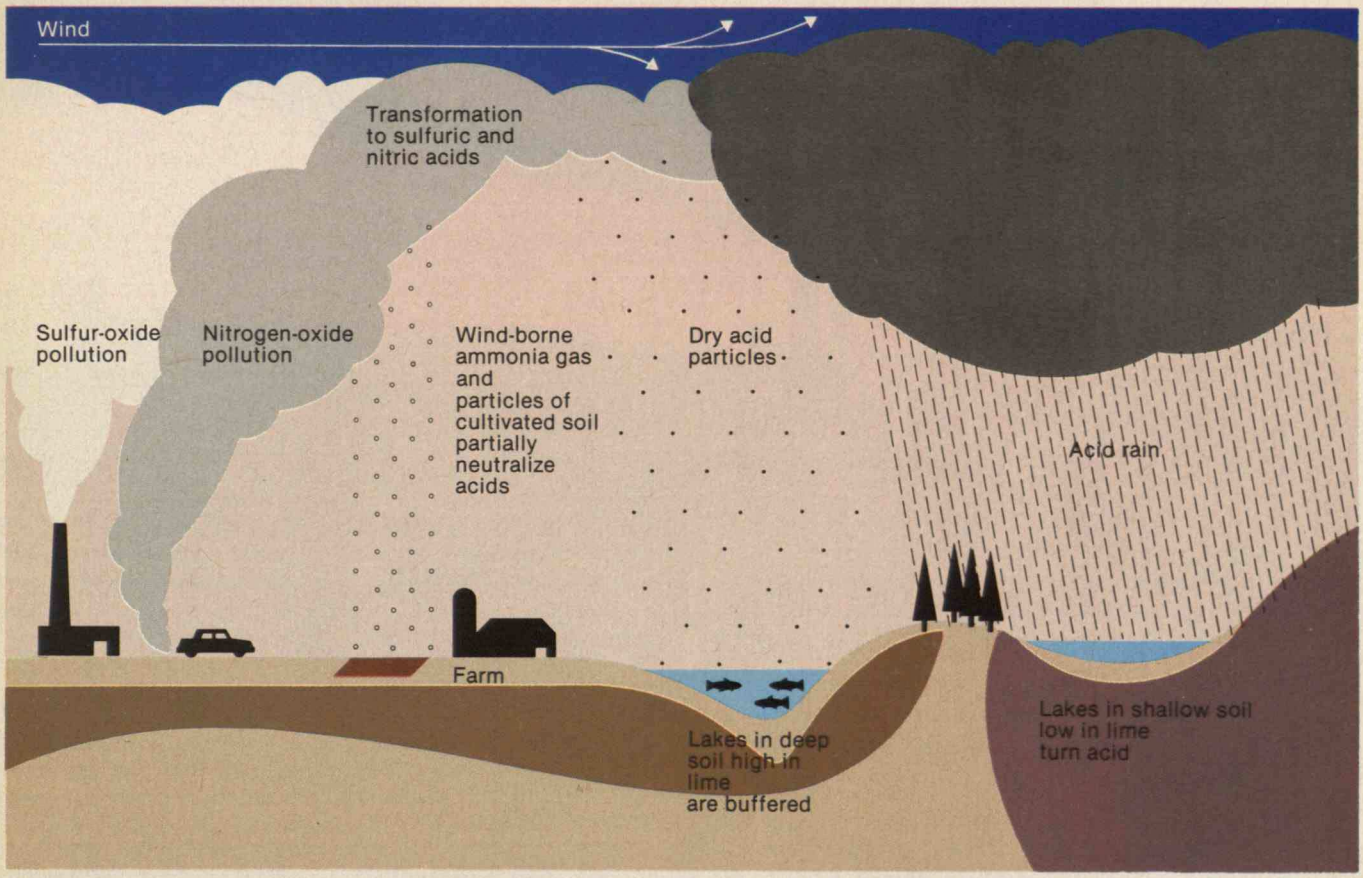
Despite unique local conditions and complex changes to acid in the atmosphere, overall patterns emerge. The acidified lakes and streams that have raised public concern are invariably near to or downwind of major urban and industrial sources of sulfur and nitrogen-oxide pollution. These include thousands of lakes and streams in southern Scandinavia as well as hundreds of lakes and streams in the Adirondacks, Maine, Ontario, and Nova Scotia. And thousands more are threatened. In areas that are upwind of or far from major urban pollution, even susceptible lakes have not become acidified, though they are threatened if acid rain worsens.

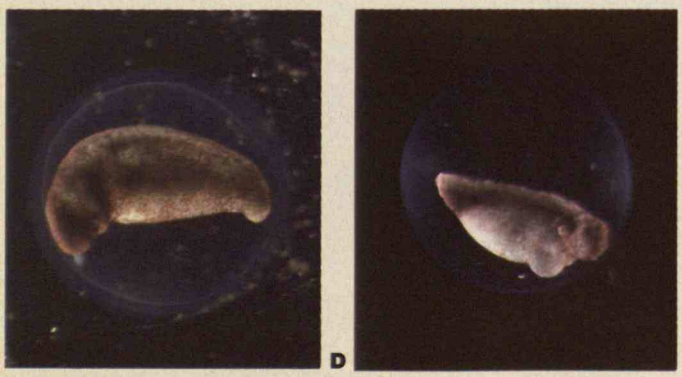
When Nature Turns Acid

Where acidification occurs, it impoverishes the diverse life of lakes, streams, and possibly forests and other environments. Acid rain leaches needed nutrients from soils and releases toxic metals such as aluminum, zinc and manganese from soils into streams and lakes. Lake waters grow unnaturally clear, communities of plants and animals change, and sensitive species, especially fish, eventually die out. Some, such as the European roach and American walleye, quickly succumb to acid, while others, such as perch and eels, are relatively resistant.

DIAGRAMS: OMNIGRAPHICS

Pollution that goes up must come down—mainly as acid. Sulfur and nitrogen oxides from electric utilities, industries, and vehicles are blown by the wind, transformed to acid, and partially neutralized by ammonia gas and particles of cultivated soil. The acids can be deposited on earth as dry particles and gases or in precipitation. Lakes on sandy, shallow, low-lime soil can rapidly turn acid.





Acidified water deforms growing salamanders, often fatally. Photos A and C show the normal embryo growing. Photo B shows an embryo in water with an acidity of pH 5.0 that has not retracted its yolk plug (the oval knob). In photo D, the embryo has swelling near its heart and a stunted posterior, usually fatal deformities. Salamanders that do survive are sometimes crippled like the one in photo E, which has a curved spine and stunted gills.

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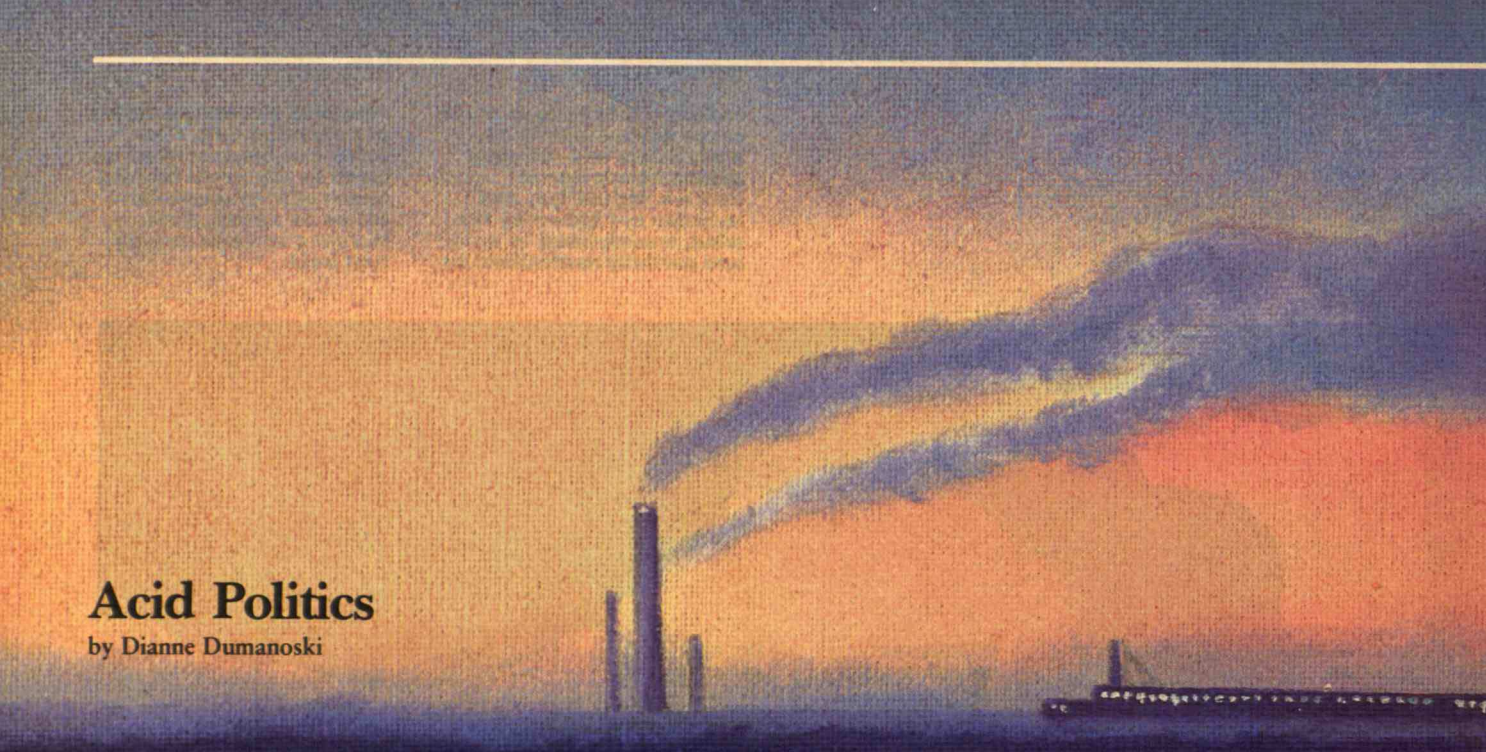

Acid Politics

by Dianne Dumanoski

When President Ronald Reagan visited Canada in April 1981, many Canadians thought it perhaps unseemly to embarrass a visiting head of state, but a crowd of 3,000 nevertheless confronted him outside Parliament. Waving tattered umbrellas and keeping up a chant of "Go home acid rain," the protesters nearly drowned out the president's remarks. The sign on a stuffed fish held aloft pleaded "save me." It was the largest demonstration ever encountered by a foreign leader in Canada's capital, according to the Department of External Affairs, and was clear evidence that acid rain is not just another environmental problem.

This complex long-distance pollution has not only pitted expected adversaries against each other—environmentalists versus coal and utility interests—it has also set region against region and country against country. Pollution pumped aloft by tall stacks in one place becomes a downwind area's acid rain. Those suffering damage can do little to stop it, and those who will bear the cost of remedies are not experiencing the problem.

Though acid rain has been showing up in many places, the principal victim is the Northeastern United States and eastern Canada, which receive large quantities of pollution on the prevailing winds from the Ohio River Valley and the industrial Midwest. By unfortunate coincidence, these regions' lakes and forests are geologically vulnerable to the resulting acid.

Canada, which considers acid rain its most serious environmental problem, has been pressing its powerful neighbor for a pollution-control treaty. The Northeastern states have fought in the courts and through the Environmental Protection Agency (EPA) to reduce interstate pollution under the Clean Air Act. But no one has made much headway.

Midwest industry—the principal cause of these regions' acid rain—has benefited from cheap electricity generated without pollution controls from high-sulfur coal mined nearby. Ohio alone, with 21 major older power plants, is the largest single source of sulfur pollution in the country, producing more than all its aggrieved downwind neighbors—New York, New Jersey, and the New England states—combined. Many of the big Midwestern polluters have failed to comply even with the Clean Air Act's existing air-pollution standards, which fall far short of what will be needed to combat acid rain.

Government efforts to get large polluters to reduce sulfur emissions have been thwarted by a formidable array of interests. When the EPA tried to make two infamous plants belonging to Cleveland Electric Illuminating (CEI)—East Lake and Avon Lake—comply with emission limits in 1979, the Carter administration found itself caught in treacherous political cross-currents.

CEI proposed to comply with the order to reduce sulfur-dioxide emissions by switching coal suppliers. Instead of burning high-sulfur Ohio coal, the company would buy low-sulfur coal from Kentucky and West Virginia.

But local miners claimed this change would cost them thousands of jobs. In emotional meetings that made national news, the Ohio coal interests implored the EPA to invoke a special provision of the Clean Air Act originally sponsored by an Ohio senator. Under this provision, the president, a governor, or the EPA administrator can order a utility to burn local coal if switching fuel to comply with the Clean Air Act will cause major unemployment or economic disruption. The utility then has to meet emissions limits by other methods, most likely by using smokestack scrubbers.

The EPA eventually concluded that switching to low-sulfur coal would cost Ohio at least 5,000 mining jobs and cause economic disruption. But the Ohio utilities launched an aggressive propaganda campaign, using radio and television commercials to tell their consumsers that scrubbers were ineffective and unreliable and would drive up utility bills for no good reason.

While the utilities were wrong about the effectiveness of scrubbers, most estimates

ILLUSTRATION: KATHERINE MAHONEY

did confirm the claim that scrubbers would add about $4 a month to the average home utility bill. Though several downwind states protested the action, President Jimmy Carter finally announced that he would relax the emissions limits for the two Cleveland plants. It was easier for a president facing a tough reelection fight to legalize the pollution than to contend with the labor and industry forces opposed to controls.

These themes—the high cost of controls and the predicted loss of jobs—have also been prominent in the congressional debate over acid-rain legislation during the past year. If anything, the shaky economy has intensified fears in states such as Ohio that serious antipollution steps would have crippling economic repercussions. The National Coal Association has predicted electrical rates will increase 38 percent to 106 percent in the Midwest, union officials fear the loss of 83,000 mining jobs, and utility officials forecast an annual cost of $7 billion a year by 1990.

But reasonable voices on both sides concur that many of these predictions are greatly exaggerated. For example, many mining jobs will not be lost. Acid-rain legislation may hurt miners in Ohio, where coal is high in sulfur, but will help those who mine low-sulfur coal in West Virginia. The Congressional Office of Technology Assessment has estimated the annual cost of acid-rain legislation to be between $2 and $4 billion. With an interstate trading strategy that would allow polluters to cooperate in developing the most cost-effective pollution controls, the costs could drop to a range of $1.7 to $3.1 billion.

In fact, the Natural Resources Defense Council (NRDC) and the Edison Electric Institute (EEI) are not that far apart in their estimates of increased electrical rates: NRDC predicts a 2 percent average increase, while EEI has talked of 4 to 5 percent average increases. Richard Ayres of the NRDC also notes that those states facing the largest increases will still have "substantially lower rates" than Northeastern states that burn more expensive and cleaner fuels.

And those pressing for swift action to stop acid rain believe that the cost of doing nothing will ultimately be higher. In a report released in September 1981, the National Academy of Sciences warned, "Emissions of sulfur and nitrogen oxides at current rates, in the face of clear evidence of serious hazard to human health and to the biosphere, will be extremely risky from a long-term economic standpoint as well as from the standpoint of biosphere protection."

A report by the Council on Environmental Quality said sulfur compounds and particulates have done $2.2 billion in damage to materials such as paints, masonry, and metals. And this is only the most obvious and easily quantified damage. By one common estimate, 48,000 Canadian lakes could turn acid in the next 20 years; a single one of them is hard to put a price on.

But as much as any economic concerns, the Reagan administration's ideological beliefs that the federal government should not interfere with private business lurk behind its environmental program. The Carter administration launched negotiations with Canadians to reduce international pollution—a Canada/U.S. study estimated that as much as 77 percent of the sulfur-dioxide pollution harming Canadian lakes comes from the United States. But that plan withered early in the Reagan administration. Instead, the administration has allowed 13 states to raise their limits on sulfur-dioxide emissions by a million tons a year, sanctioning pollution from many power plants that previously violated clean-air standards.

The Reagan administration has actively opposed acid-rain legislation on the grounds that more scientific evidence is needed to warrant imposing such expensive controls. Coal, utility, and other industrial interests have forwarded the same argument. A publication by the Edison Electric Institute entitled "An Updated Perspective on Acid Rain" concludes: "Acid rain is still a puzzle." Indeed,

(continued on next page)

(continued from page 65)
business interests have rallied behind the "we need more study" argument in almost every major environmental battle, including the fight for the Clean Air Act in 1970.

But prudent policy decisions can be made, and often must be made, in the face of some degree of uncertainty. A report issued last fall by the Committee on the Atmosphere and the Biosphere of the National Research Council said the evidence on acid rain "is disturbing enough to merit prompt tightening of restrictions on atmospheric emissions of fossil fuels and other large sources." Even in Ohio, a scientific advisory force appointed by the governor urged taking "reasonable measures to ensure that emissions of acid-forming gases be further reduced."

Attempting to press forward, the Canadian government proposed earlier this year that both Canada and the United States cut sulfur-dioxide emissions in half by 1990. "If we wait much longer," the minister of the environment, John Roberts, has said, "we will have lost our entire lake system in eastern Canada." To the chagrin of the White House, the Canadian government has been lobbying in Congress, where a variety of bills to control acid-rain pollution are under consideration.

American environmentalists have found the Canadians a valuable ally. "The respect that a government gets is above and beyond that of a private lobbyist," said one. "[Canada has] had an important impact, especially since the Reagan administration doesn't have much credibility on this issue." Also important is the growth of national sports groups such as Ducks Unlimited, which have added their voices to those calling for an end to acid rain.

If acid rain legislation was a long shot a year ago, some would now give it even odds, and the issue shows no signs of dying away. Legislation may not pass this year, but those who are pushing for it will surely be back. □

Dianne Dumanoski is a staff writer for the Boston Globe. *She covers, among other issues, acid rain.*

Aluminum, leached by acid rain from sensitive soils, coagulates the mucus coatings of fish's gills and interferes with their ability to breathe. Acid also upsets the salt balance in fish's blood. Fish spawn and hatch fewer eggs, the embryos may be malformed, and when a new generation does hatch, their growth is often retarded. Acid water rushing into lakes from the snowmelt may kill fish. Animals such as crayfish, which have calcified outer skeletons instead of interior bones, apparently cannot recalcify new skeletons after moulting, so they become vulnerable to predators and infections.

As for forests, studies in Germany suggest (although we cannot yet draw firm conclusions) that as acid rain frees toxic aluminum in the soil, it damages the fine tree roots. Recent studies in the New Jersey pine barrens have shown that three species of pine grow more slowly beside acidified streams. Other factors such as drought, fire, pests, and ozone air pollution do not seem to be responsible.

We know that poor soils have already undergone a slow natural process of acidification that leaches out essential plant nutrients and alters communities of organisms. Especially when these poor soils lie on bedrocks such as granite and quartzite that are scant in lime, or when the forest is growing on moderately acid peat, acid rain may hasten this natural process. Changes that normally take many centuries may occur in several decades or a few centuries. Nitrate in acid rain can actually benefit forest growth at first, because nitrogen is often the nutrient trees most lack. But eventually acidity may hinder the ability of the forest's bacteria and fungi to recycle nitrogen from decaying plants into the soil, robbing the trees of as much nitrogen as the rain deposits. And in the long run, the acid rain also leaches out other essential nutrients such as phosphorus, potassium, magnesium, and calcium.

Acid precipitation may also damage farms, cities, and even people—in addition to the more direct harm that sulfur and nitrogen oxides, themselves air pollutants, inflict before turning into acids. Studies on field crops have produced contradictory results, but in one of the best recent experiments, soybeans were exposed to simulated rainfalls of pH 5.6, 4.1, 3.3, and 2.7. At the pH levels below 5.6, yields declined by 11, 17, and 24 percent, chiefly because the numer of pods on the plants decreased.

Both sulfur and nitrogen oxides and the acids they produce corrode monuments such as the Parthenon and rust cars and metal structures. Acidic lakes, streams, and possibly groundwaters that feed municipal reservoirs may leach toxic lead and copper from pipes into drinking water. And the sulfate particles that contribute to acid precipitation penetrate deep into humans' lungs and may worsen lung and other diseases.

A Call for Action

Researchers still need to learn far more about natural controls on acidity, toxins such as lead and mercury, suspected carcinogens such as benzpyrene, dry deposition that is difficult to measure, and the balance between local fallout and long-distance transport. Much as scientists have investigated how much a

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When acid deposition affects municipal reservoirs, toxic lead and copper may be leached from pipes into drinking water.

given amount of phosphate from detergents or fertilizers damages lakes, they have to determine the damage a given amount of acid deposition causes—and how fast lakes recover after it ceases. Harm to forest growth, which could become extremely serious, must be studied over one or two generations of trees, lasting several decades each. We have to learn more about how acid precipitation brings about change over time, as suggested by the Scandinavian studies. We have to look at whole watersheds, including their chemical cycles, and the life cycles of their plants and animals. There are no quick answers to environmental questions.

Unfortunately, long-term interdisciplinary studies of this kind are not usually funded by federal and state agencies. They seldom finance studies that last for more than two or three years, and they are strongly oriented toward well-established disciplines such as fisheries and forestry. Some research areas now receive no support at all. For instance, the effects of acid rain on wetlands have been almost totally neglected. However, the federal government's National Acid Precipitation Assessment Program, involving 12 agencies cooperating over a ten-year period and budgeted at about $18 million dollars this year, is clearly a major step in the right direction.

In the meantime, the weight of all the evidence indicates that acid deposition is a serious and widespread environmental problem, caused largely by sulfur and nitrogen-oxide pollution. Nearly all of the scientists actively studying the problem agree. The Canadian government regards acid rain as Canada's most critical environmental problem. And President Jimmy Carter's environmental message of 1979 called acid rain "one of the two most serious global environmental problems associated with fossil-fuel combustion." (The other is the "greenhouse effect" that will occur in the next 50 to 100 years as accumulating carbon dioxide, also from fossil-fuel combustion, traps heat in the atmosphere and warms the climate.) I believe—as do the governments of Canada, Norway, Sweden, and West Germany, as well as the governors of six American states, the premiers of five Canadian provinces, the Senate Committee on the Environment, and the U.S.-Canada International Joint Commission—that the evidence of damage from acid rain justifies a major attempt to reduce it.

Industry often argues that we should wait until the evidence is much stronger, but there is ample precedent for action on environmental problems even when the chain of causation is unclear. For example, in 1952, when I was living in London, the Great Smog killed between 2,500 and 4,000 people in a week, three or more times the normal death rate. No one contests that statement, yet the chain of causation still has not been completely worked out—it was certainly far from clear at the time of the incident. Nevertheless, the authorities, acting largely upon circumstantial evidence, made great progress in cleaning up the London air. I doubt that anyone suggests they were wrong to take this very expensive action or that the regulations they issued ought to be rescinded.

Governments and industries regularly initiate far-reaching and expensive social and economic programs based on evidence not nearly as convincing as in the case of acid rain, where there is already major ecological and corrosive damage. Environmental programs should not require evidence far greater than is demanded of other initiatives, nor should the burden of proof be on the opponents of pollution. If we wait until the last scintilla of evidence has been gathered and the entire chain of causation is proved, a fragile part of life on our planet will have been damaged. Even if appropriate legislation were enacted today, it would probably take from five to ten years to affect emissions significantly.

Allowing acid rain to continue also raises questions of equity. Should one country be allowed to damage another's landscape with air pollutants, whether or not it offers to pay to clean up the damage? Acid rain violates Principle 21 of the 1972 Stockholm Declaration, endorsed by both the United States and Canada. The declaration affirms that states have "the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or areas beyond the limits of national jurisdiction."

What to Do Now

Liming lakes is one temporary way to neutralize them and preserve threatened fish, but it is not a long-term solution. Lime cannot readily be applied over more than a small fraction of the sensitive areas liable to undergo serious acidification. The tremendous resources necessary for a regionwide liming program would be much better directed toward controlling the

Goblin and Devil's Copper

Hundreds of years ago, German copper miners were annoyed by two types of rock—one blue and the other green. There was too much of the worthless blue mineral, and the miners hated picking it out of the copper ore. They called it by a German word meaning goblin. The green mineral looked like copper ore but yielded nothing valuable, so they called it devil's copper.

In the 1700's, Swedish chemist Georg Brandt decided to find out more about the blue rock. His student, Axel Cronstedt, tackled the green rock. They had no way of knowing that two centuries later their experiments would be vital to jet travel.

Brandt pulverized a piece of "goblin," mixed it with charcoal powder, and heated it. When he took the mixture out of the oven, it contained silvery white crystals of metal. He held a magnet near and the crystals were attracted. The only known magnetic metal was iron, but tests showed the crystals weren't iron. Other tests confirmed that Brandt had discovered a new metal. He named it "goblin" after its source. In German this is *kobold*, or cobalt in English.

Cronstedt heated devil's copper to form an oxide, then heated the oxide with charcoal. The result was magnetic metal crystals that looked like cobalt, but proved not to be that or any other known substance. He named his discovery *kupfernickel* in German, which he shortened to nickel.

Of the many uses found for cobalt and nickel over the years since Brandt and Cronstedt freed them from colored rocks, one of the most important is in jet engines.

The cores of running jets are red hot, and key parts rotate so fast ordinary materials would fly apart. Engine designers want the parts to run as hot and fast as possible. Laws of physics say this makes engines most efficient, and thus most powerful or least fuel-hungry. But temperatures and speeds are limited by the heat-resistance and strength of engine parts. The best engine-core materials developed so far are superalloys: metallic mixtures based on nickel or cobalt to which several other elements have been added.

Pratt & Whitney formulates superalloys especially for the engines it develops and builds. In its new PW2037 engine, the alloys withstand severe centrifugal stresses and temperatures approaching 2,000 degrees Fahrenheit. Fuel economy is paramount in the PW2037, which offers improvements of more than 30% compared to earlier-developed engines it is designed to replace. That amounts to annual savings per aircraft of about $1 million.

The findings of two Swedish chemists who brought a couple of rocks into their laboratories became part of modern flight technology. The story of Brandt and Cronstedt is just one example among many of science serving people through technology.

In 1952,
the Great Smog in London
killed over 2,500 people in a week. Authorities acted largely on
circumstantial evidence and cleaned up
the air.

problem at its source. Moreover, liming does not restore a lake to its prior state—it alters plant and animal communities. These changes would be unacceptable in preserves set aside as natural wilderness.

Instead, we should focus on the many options for reducing emissions: using coal washing, stack scrubbers, new combustion technologies, low-sulfur fuels, and alternative energy sources such as sun, wind, water, and biomass. Conservation is the most environmentally sound option, and it can be cost-effective and need not compromise human welfare.

Although acid deposition is a complicated process, I believe we can set reasonable guidelines for reducing emissions. The first question is how much we need to reduce the acidity of the rain. The National Research Council's Committee on the Atmosphere and Biosphere has suggested that the average acidity of precipitation should not exceed a pH of 4.6 to 4.7. Below that level, sensitive lakes turn acid. Because pH in the areas of the United States and Canada most affected by acid precipitation is often below 4.3—more than twice as acid as the critical level—acid deposition would have to be reduced at least 50 percent.

The second question is whether sulfuric or nitric acid does more harm. We know that somewhere downwind, all sulfur-dioxide emissions are eventually oxidized to sulfuric acid. Nitrogen oxides are similarly oxidized to nitric acid, but a good deal of it is consumed by plants. Thus, the amount of sulfate deposited may provide the best guide as to whether lakes will become acidified.

The third question is how much we should reduce sulfate deposition. To find the answer, we can compare the levels of sulfate deposition in areas where lakes have not been acidified with the levels that have led to various degrees of lake acidification.

Annual sulfate deposition is about 7 to 14 kilograms per hectare in northwestern Ontario and 10 to 18 kilograms per hectare in northern Minnesota. No sensitive clearwater lakes seem to have become acidified in either place. Deposition in areas harmed by acid rain exceeds these ranges. For example, Nova Scotia receives 25 kilograms per hectare, and numerous lakes and salmon rivers have been acidified to the point of losing their fish. In the heavily polluted Adirondack Mountains, which receive 43 kilograms of sulfate per hectare, more than 200 lakes have lost their fish.

This evidence suggests that staged cutbacks to reduce annual sulfate deposition in sensitive areas to below 20 kilograms per hectare—to a little less than half the deposition in the Adirondacks—would be reasonable. Eventual further reductions to 15 kilograms per hectare would allow a margin of safety.

The fourth question is: to reduce sulfates by 50 percent, how much do we need to cut sulfur-dioxide pollution? I agree with the scientists at this year's Stockholm Conference on the Acidification of the Environment that sulfate deposition is likely to be roughly proportional to sulfur dioxide emissions. Thus, an appropriate goal for the present is to reduce emissions by 50 percent.

Earlier this year the Canadian government proposed to reduce sulfur-dioxide emissions by 50 percent over the next decade if the United States does the same, and the West German government is already planning to reduce emissions by nearly 50 percent. The response is up to the United States. Surely a clean environment is within our reach if we have the political will to attain it.

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EVILLE GORHAM, a professor in the Department of Ecology and Behavioral Biology at the University of Minnesota, has been studying acid rain since the 1950s. He is a member of the U.S./Canadian Joint Scientific Committee on Acid Precipitation and has served on other scientific committees assessing the problem.

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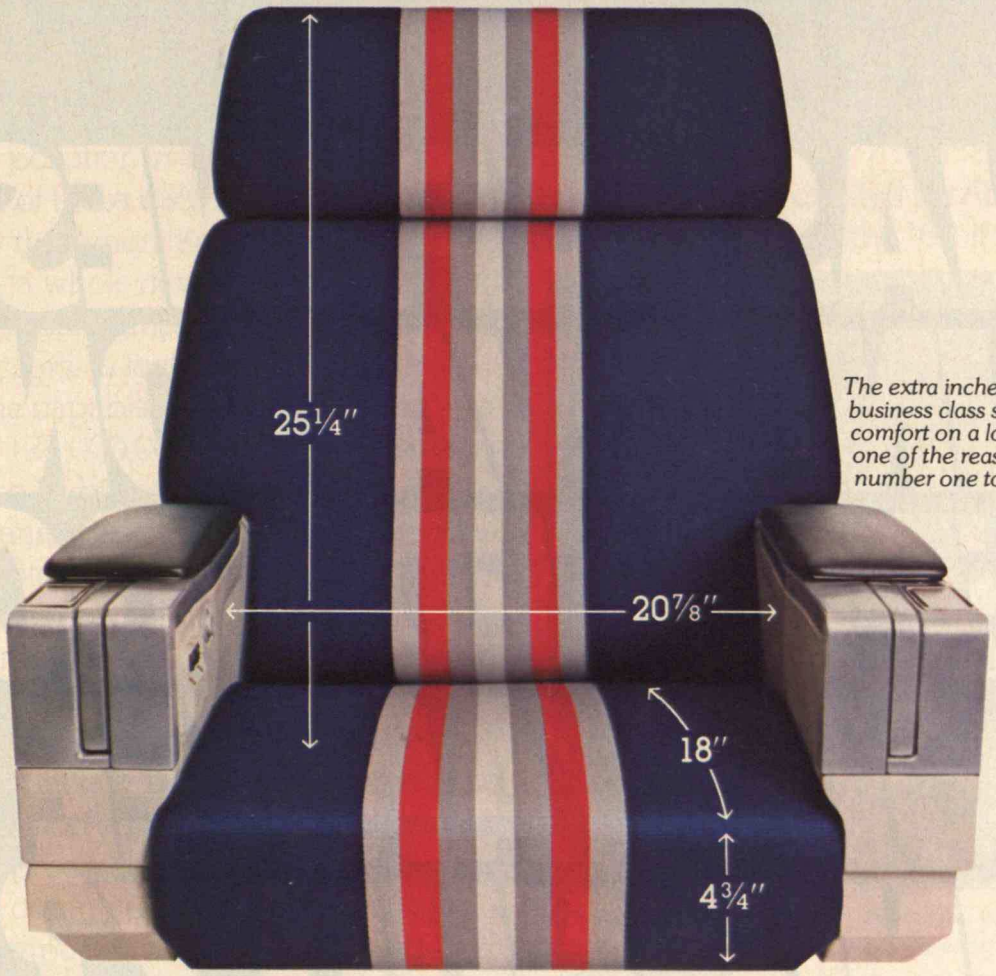

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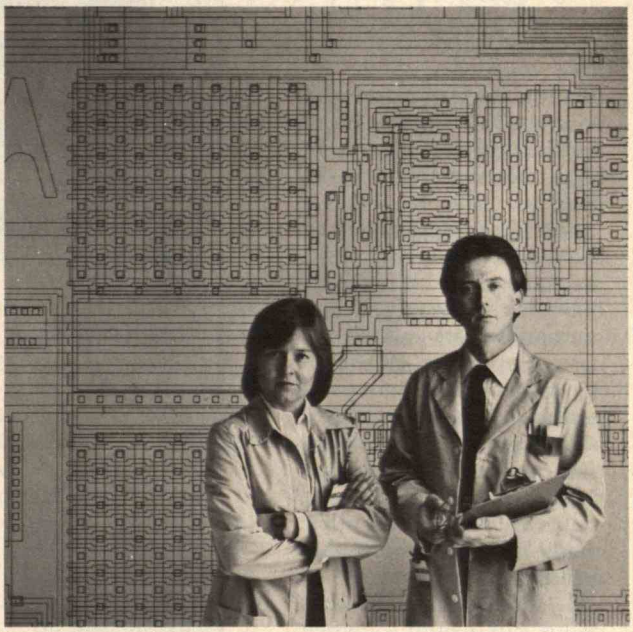

A single engineering drawing for the MC68000 covers an entire wall. Yet the actual microprocessor is only about 1/4 inch square.

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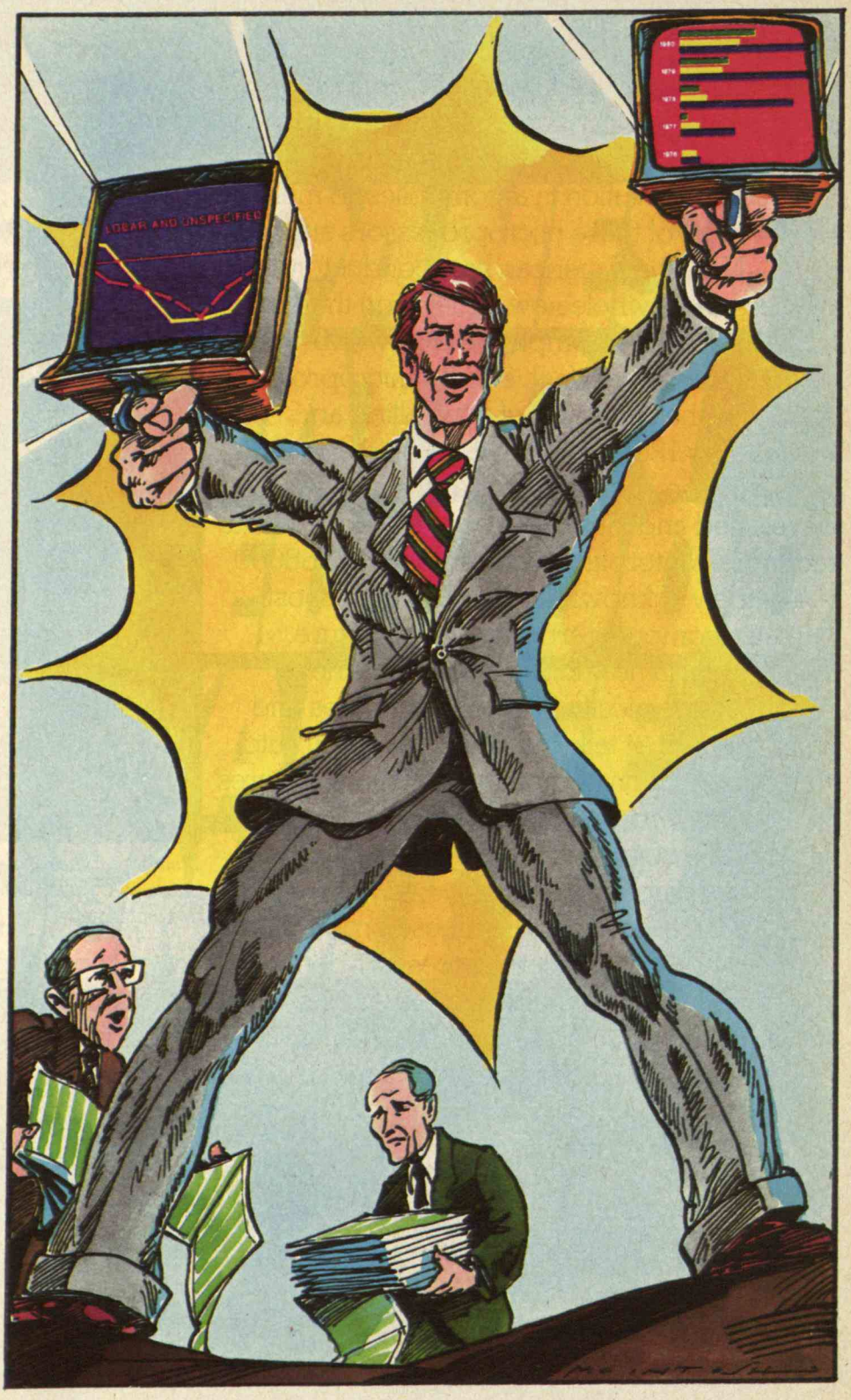
Computer Graphics on Every Desk?

Back in the sixties, futurists predicted that executives would soon enjoy instant computerized access to everything they always wanted to know about their businesses. Those visionaries must never have wrestled with the infamous fanfold computer printout. Their "management information systems" revolution seemed like futurist hype.

But with the advent of color computer graphics, the revolution may be upon us. Bulky lists of nearly incomprehensible data quickly become clear when converted into graphic form. Instead of poring over dull listings of accounts receivable, executives can now, at the touch of a finger, control the hue, saturation, and brightness of pie charts and bar graphs that depict the same numbers.

Besides, everybody likes color. For example, when Steve Schnipper, a salesman at Datapoint in San Antonio, recently went to a trade show to sell word processors, which print mere dull words, he brought along a color business graphics system because "I knew it would draw a crowd." And it did. Schnipper felt very smug at having outthought his competitors.

Managers are learning that other managers, also, like colors. To make a point at a meeting, a picture is worth a thousand numbers, as Dr. Lynn Oppenheim at the University of Pennsylvania's Wharton School of Business has recently verified. Meetings are significantly shorter, her experiments showed, when people giving presenta-



ILLUSTRATIONS: JON MCINTOSH

tions use graphic aids. And for those who don't mind being cooped up with cigar smokers, Oppenheim documents a more potent lure to business graphics. If you pit an executive armed with overhead transparencies against another who must rely on mere written backup material, the one with the visuals typically wins over two-thirds of the audience.

Color graphics give executives such an edge in business that they're reluctant to share a centralized system. For one thing, as Mike Toback at the Lawrence Livermore National Laboratory learned, what is yours to share may not be yours to keep. Last winter Toback programmed the computer so middle managers could create color images on their terminals to do things like check how their money for contracts was holding out and call up the status of weapons test schedules. But then another branch of Lawrence Livermore managed to commandeer the shared terminals, and the people who relied on Toback's system are back to using—yes, how primitive—computer-displayed words and numbers. "We hope to correct this in a few months," said Toback. As soon as he can get his hands on some more color terminals.

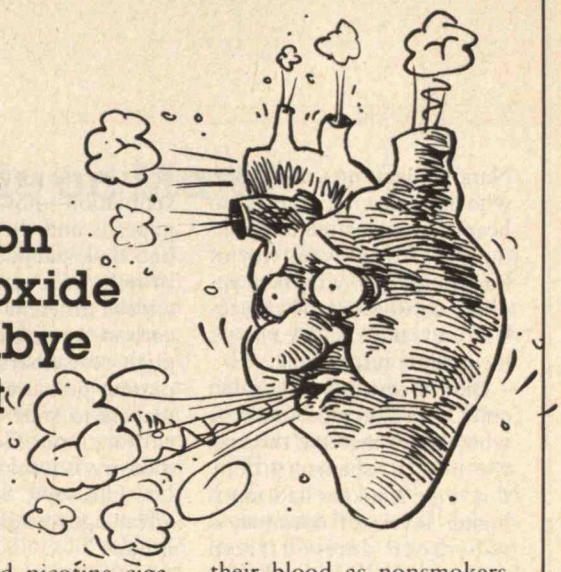
To stay clear of conflicts, Datapoint's customers all insist on buying their own color business graphics systems, despite the $60,000 price tag. "I sold six to one company," says Schnipper. It's a holding company, and the six financial VPs each wanted personal control over his own system to chart the performance of his empire.

Computer manufacturers are gambling that computer business graphics will turn into even more of a boom when they bring out systems in the $10,000 price range so middle managers can have their own, too. "Every [microcomputer] company I have talked to is bringing out one with excellent graphics capabilities within the next year," promises John Gordon at Graphic Software Systems, Inc., in Wilsonville,Ore. New programs will turn these graphics-oriented microcomputers into dream machines, he says, that in only seconds can give the hard-pressed executive the artwork to win a boardroom battle.

Already several adequate graphics systems are available on microcomputers costing under $2,000. One contender in the economy sweepstakes, Target Image Maker, offers a program for $175 that runs on an inexpensive Apple II computer to generate color charts on a TV set. If you don't want to lug your computer and TV to meetings, you can send your data over the phone to the nearest Target Image Maker center. There cameras and printers quickly turn the data into finished graphics on paper. And if you want your own, color printers have recently fallen below the $2,000 mark.

Color computer graphics might not replace crayons, but if Gordon at Graphic Software is right, briefcases will lighten as color charts replace volumes of computer printouts.—*Carolyn Meinel* □

Hello Carbon Monoxide Goodbye Heart



Low tar and nicotine cigarettes may pose a greater health hazard than high tar and nicotine brands. Tar is, of course, the culprit in smoke that causes lung cancer, and nicotine is probably the addictive drug. But recent studies hint broadly that carbon monoxide—that colorless, odorless, very toxic gas also found in car exhaust—is responsible for smokers' high rate of heart disease.

Incomplete combustion of any material containing carbon produces carbon monoxide. When carbon monoxide enters the bloodstream through the lungs, it binds with hemoglobin to form carboxyhemoglobin, which prevents the hemoglobin from performing its usual function of carrying oxygen. As a result, the heart must work harder to pump enough oxygen to all parts of the body.

Research in the United States on the connection among smoking, carbon monoxide, and heart disease has been piecemeal. The first examination of carbon-monoxide levels in the blood in a representative sample of the U.S. population, as reported in March by the National Center for Health Statistics, shows that current smokers have four times as much carboxyhemoglobin in their blood as nonsmokers. And Matt Petrovick and several associates in the Environmental Protection Agency have observed that the heart is placed under extra stress and beats more asymetrically when exposed to carbon monoxide.

A forthcoming English study is the first to make the leap from cigarette smoking to heart disease via carbon monoxide. Reviewing health statistics on smoking and heart disease, Nicholas Wald at the Radcliffe Infirmary in Oxford and Marion Idle at the BUPA Medical Center in London observed that an average pipe smoker has a risk of heart disease little if any greater than a nonsmoker. Cigarette smokers, on the other hand, have five to ten times this risk, depending on age and other variables. Having found this decisive correlation, the English researchers took blood samples from both pipe smokers and cigarette smokers. The carboxyhemoglobin level in pipe smokers was 2.2 percent, while that in cigarette smokers was 4.7 percent. More carbon monoxide reaches the bloodstream of the cigarette smokers because they inhale the smoke. This apparently accounts for their higher rate of heart disease.

Some controversy remains. Dr. Edward Rocchila at the

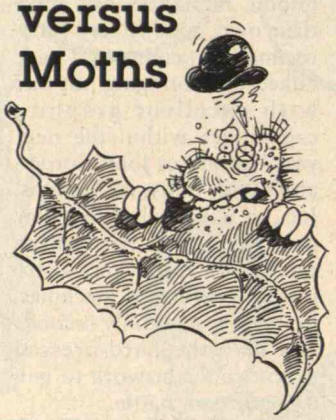
National Institutes of Health, who is reviewing studies on heart attacks related to smoking, says "there is no way of knowing" yet whether another constituent of the tobacco smoke, perhaps nicotine, is responsible.

But the research in London and Oxford on pipe smokers, who absorb nicotine through the mouth, seems to deny this. Pipe smokers had much higher levels of cotinine, a substance derived from nicotine, in their blood than cigarette smokers, but a much lower incidence of heart disease. Thus, Dr. Idle told *Technology Review*, "There is no physiological evidence for nicotine, and we really don't think there is any other constituent in smoke large enough to be causing heart disease."

What is a smoker to do? The amount of carbon monoxide delivered by a cigarette depends on its ventilation—how porous the paper is and the way the tobacco is packed. Different brands of cigarettes yield widely different amounts of carbon monoxide. The English reseachers have been putting pressure on cigarette makers to start reducing the carbon monoxide, and the industry is working on it. As Dr. Idle says, "It's to their advantage to start controlling it now."

So far cigarette makers don't even list carbon-monoxide yields. Doing so would pose a choice, because low carbon monoxide does not necessarily go along with low tar and nicotine. But heart disease is much more common among smokers than lung cancer, so for those who do not give up cigarettes altogether, a low carbon-monoxide brand might be best.—*Susan E. Katz* □

Trees versus Moths



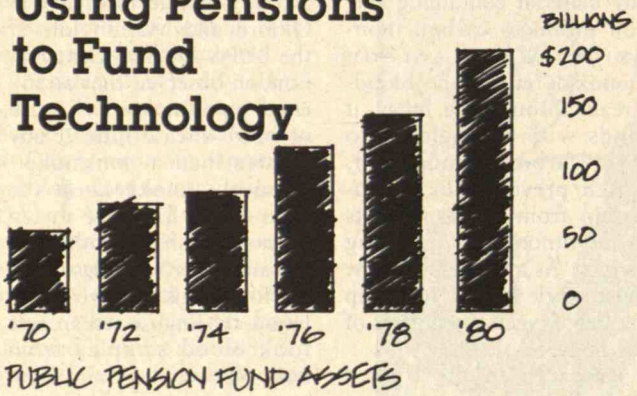
Trees stripped of their leaves by gypsy-moth larvae are not wholly passive victims: they fight back.

When the leaves of red oak trees in eastern Vermont that were defoliated in 1980 regrew the next spring, they were tougher and had lower water content than leaves of trees that were unaffected, according to Jack C. Schultz and Ian T. Baldwin of the Department of Biological Sciences at Dartmouth College.

The 1981 leaves were significantly less accessible to and less nutritious for larvae than those of the previous year, Drs. Schultz and Baldwin write in the July 9 issue of *Science*. The biologists are convinced that the changes they observed are "great enough to reduce larval growth and influence the course of outbreaks."

But the causes of these effects are unclear, and other observers have found that leaves change to become more resistant to gypsy moths even within a single season. Research continues, because the scientists believe that this complex set of processes may help account for a larger mystery: why gypsy moth populations suddenly explode and as suddenly crash.—*J.M.* □

Using Pensions to Fund Technology



Small, young technology firms in places like the Silicon Valley south of San Francisco and the Route 128 beltway surrounding Boston have fared far better than conventional heavy industry in the recession of 1982. Indeed, in a widely-quoted study, David L. Birch in the Department of Urban Studies and Planning at M.I.T. showed that two-thirds of all new jobs in the U.S. are created in firms with 20 or fewer employees—and 80 percent in "establishments" (including new divisions of existing companies) less than four years old.

State legislators would like to foster new jobs, and they are passing laws to permit the nation's public pension funds, with $200 billion in assets, to invest in promising, largely high-technology companies. This is an American-grown answer to the Bank of Japan, which has infused massive sums into the large, organized industries for which the Japanese have become legendary.

Investing in small firms is an about-face for the pension funds. A typical case is California, where pension funds have $30 billion in assets but where the state constitution requires that they be handled most conservatively. Pension-fund managers can invest only in corporations worth over $100 million that have publicly traded stock and meet rigid requirements on paying dividends. So much for, say, the Intel Corporation in its early years, when it consisted basically of its president Robert Noyce, some colleagues, and an idea called integrated circuits. Of the 100 fastest-growing firms in California, pension-fund managers are permitted to invest in only 7. But the legislature passed a constitutional amendment to change that, and the measure goes to the voters for final approval in November.

Michigan recently passed a law allowing its pension-fund managers to invest up to 5 percent of their assets, or about $400 million, as venture capital. Al Bogdan, special assistant to the governor, says he would be happy to see $20 million a year invested primarily in new technology companies. That may not sound like much in the United States economy. It may not even sound like much venture capital in a place like Boston. But in Michigan, with only a

few established venture-capital funds, that money could make a difference. "For a guy coming up with an idea in his basement," says Bogdan, "it's a big trip from Detroit to Boston."

Ohio also passed a measure, effective November of last year, allowing it to invest up to 5 percent of its public pension funds in small Ohio corporations—but not necessarily technology companies. Robert McLaughlin, investment officer at the Public Employees Retirement System, says he expects excellent returns—around $10 million on a $2 million investment in five years. These small, young firms may be risky, but they do grow faster than the Fortune 500.

McLaughlin is concerned, however, that he will not find enough good ideas to invest in. The question is whether the United States has a shortage of investment money for future Noyces or simply a shortage of future Noyces.

Bogdan doesn't worry on this score. He believes that the availability of venture capital itself encourages entrepreneurs to solidify ideas and start companies: "When people smell money, they're willing to take a risk."

The availability of venture capital in Boston and the Silicon Valley—though from private, not public funds—is one explanation of why these areas spawned so many high-technology companies. State pension-plan managers in places like Michigan hope to do more of the same. Kenneth Kirkland, director of state and local finance for the National Conference of State Legislatures, has said that such alternative investing of pension funds "will be the single hottest issue among legislators over the next three or four years."—*J.S.* □

People on Mars?

The Viking explorations have satisfied almost everyone that there is no life as we know it on Mars. But there should be.

"The establishment of manned bases on Mars is a practical, unifying goal for the entire U.S. space program for the next century," Carol Stoker of the Department of Astro-Geophysics at the University of Colorado told the American Institute of Aeronautics and Astronautics early this year. Colonizing Mars would give us a gateway to the outer solar system and even a place of refuge should earth become unfit for human habitation.

Mars has atmosphere, gravity, and "all the elements necessary to support life," according to Dr. Stoker. The critical element is water, which is apparently scarce. A whitecap of ice appears at the north pole during the Martian winter, and pictures taken by the *Viking 1* lander show a coating of frost on everything in sight. So Dr. Stoker assumes that water for a Martian colony could be extracted from the atmosphere and perhaps from the soil.

The atmosphere of Mars is mostly carbon dioxide. It could be reacted with hydrogen from water to produce methane fuel, and could also be made to yield oxygen for breathing and burning fuel, with methanol and other organic chemicals as by-products. The Martian soil could grow plants and yield building materials, chemicals, and probably metals. Fertilizer (if needed) could be obtained from the atmospheric nitrogen.

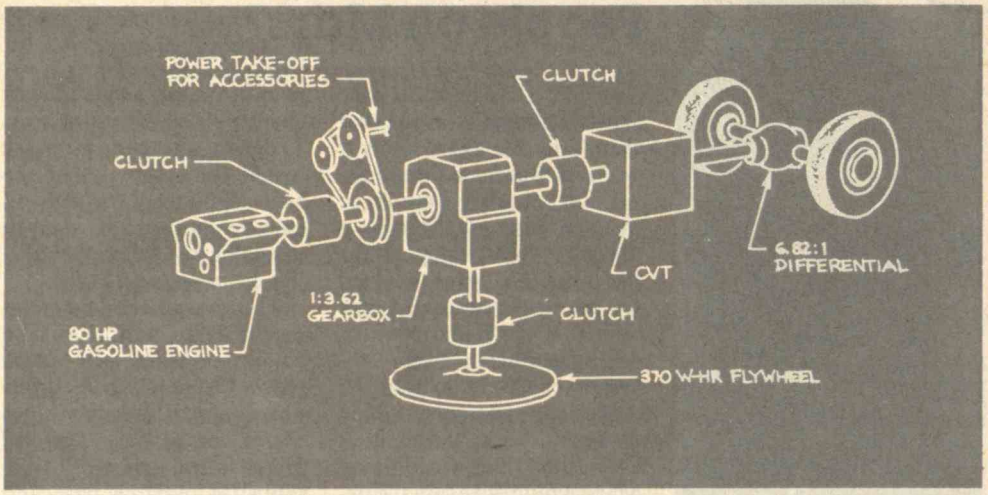
A program to colonize Mars would begin with several orbiters making high-resolution photographs to identify possible landing sites. Then an unmanned lander would bring samples of the Martian atmosphere and soil back to Earth, to be used in designing the colony's housing, factories, and farms.

The goal of the first manned mission would not be colonizing Mars itself but its moon Deimos, which orbits about 24,000 kilometers above the planet's surface. Here astronauts would establish a research base and operate unmanned rovers in detailed exploration of the Martian surface. The astronauts would analyze soil samples from Mars, pinpoint landing sites, and perhaps bring in supplies for the eventual colonizers. Finally would come the Martian colony itself, which might become self-sufficient for its major life-support materials within a decade. Started now, this process could lead to a first manned landing on the red planet to celebrate the arrival of the twenty-first century.

The space shuttle puts a Mars landing within reach. A first shuttle-launched mission to Mars would cost less than the Apollo program, and later unmanned missions would cost no more than half that, according to Dr. Stoker. New propulsion, life-support, and robotics systems might bring these costs down to within "a small fraction" of the Apollo program.

Building and sustaining a Martian colony would be more expensive. But "considering the profound implications for the economic, social, and political future of the nation," Dr. Stoker said, "program costs should not be a deterrent."—*J.M.* □

ILLUSTRATIONS: JON MCINTOSH



The power train for a flywheel taxicab. A flywheel powers the vehicle through a transmission. In turn, the flywheel draws energy from the vehicle when the latter is slowed down and, when necessary, from the small constant-speed gasoline engine. Mounted in a standard Checker cab, the hybrid engine-flywheel system would yield 32 mpg in urban driving; a cab with conventional power averages just over 10 mpg.

Saving Energy with Spinning Flywheels

Must most of the energy spent to accelerate a vehicle be lost to heat in its brakes when the time comes to slow down? Engineers seeking to close this loophole are turning to flywheels, which store momentum like fast-spinning potter's wheels, to retain and reuse the energy of braking vehicles.

David B. Eisenhaure and his colleagues at the Charles Stark Draper Laboratory in Cambridge propose putting a flywheel in a New York City taxi. A small and efficient gasoline engine would operate intermittently to drive the flywheel, which would propel the car through a transmission. To bring the car to a stop, the transmission would slow the wheels by using their energy to speed up the flywheel.

According to researchers at Draper, a standard Checker cab with such a flywheel system would give over 32 miles per gallon in typical urban driving—in contrast to present performance of 10 to 11 miles per gallon. The capital cost of the flywheel system might be $8,000, and it would pay for itself in nine months of full-time taxi service, according to Mr. Eisenhaure. It's one of the most attractive flywheel-based concepts yet analyzed, he says.

The same kind of opportunity may occur on trolleys and electric-powered urban buses. According to L.J. Lawson of the Garrett Corp. in Los Angeles, such a flywheel-equipped vehicle would receive energy from braking and intermittently from wires, eliminating the need for expensive continuous electrification. A similar application to a railroad switching locomotive would require a flywheel the size of a boxcar, says Donald L. Spanton of the Federal Railroad Administration (FRA), and the savings would not justify the flywheel's cost.

But flywheels may still find work on the railroad. A large freight train dissipates enough energy in its brakes while descending the Santa Fe's Cajon Pass in California to supply a residential community of 30,000 people with electricity. An FRA study proposes electrifying the Cajon Pass line and installing a flywheel storage system beside the tracks to capture the train's energy until the next train needs it to climb back up. Every train thus helped over Cajon Pass would save 500 gallons of diesel fuel. The FRA thinks there may be as many as 80 sites on nine major railroads where such flywheel installations could pay good dividends.—*J.M.* □

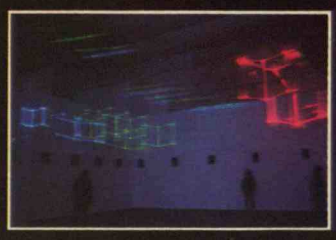
Lightmusic

The overwhelming lightmusic piece *Modulations* by Paul Earls, a composer and fellow at M.I.T.'s Center for Advanced Visual Studies, is a theater in which the actors are laser-traced images prodded into motion by computer music.

The deep timbre pervading the composition sends out heavy notes from the loudspeaker in the back, while 16 other speakers relay portions of the piece in delayed succession. The audience sees the music in the laser images driven by the same computer program as the score. The green, blue, yellow, red, and gold images range from conventional figures such as fish, roses, lips, and eyes to abstract crumples of light and jagged streaks of color.

The marvel of light and sound together may be as old as thunder and lightning, but nothing in human art has quite matched the compelling power of computer music in concert with laser imagery. True, composers have paired computer music with every imaginable form of kinetic light—computer-timed light-bulb matrices, slide shows, videotapes, and strobelights. And lasers have been used and abused in commercial advertising, discotheques, and rock concerts. But coupling media often fails. The pastoral theme of Beethoven's Sixth Symphony driving high-tech laser imagery, for example, would be an unnerving anachronism.

Lowell Cross of the University of Iowa School of Music, who took lightmusic to Expo '70 in Osaka, Japan, believes electronic music and lasers are true partners because they are technological peers. The composer pro-



"Modulations—an Installation of Music and Lasers in Space" at M.I.T.'s Hayden Gallery in January, 1982. Multicolored laser projections change their size and shape in response to computer-generated music.

grams the computer to generate pure sound waves or to alter sound waves recorded from the real world—be they from an opera singer or a midtown Manhattan bus. These remade waves are then played through speakers. The composer or designer also programs the computer to control the angles of mirrors that direct the laser beams in conscious patterns. The computer's rapid calculations provide the technological basis for a musical instrument and an artistic medium.

Computer music and coherent laser light have a similar intensity, but intensity does not mean uniformity. Rapid changes of mood mark the lightmusic. Sometimes the mood is harsh. The music's incessant thumping is accompanied by pulsating coils of laser light, concentrating in one corner and thrashing throughout the room. But then multicolored roses take over the scene, flipping and dancing to relaxing rhythms. There are humorous passages, such as the incredible stretchable silouette of a man. Later huge eyes with enlarging and contracting lachrymal glands look down in melancholy.

Adopting technology's tools, lightmusic describes the pace and intensity of the world technology has created. This art provides "a method of intuition and formulation of language," says Otto Peine, the director of the Center for Advanced Visual Studies. A roomful of fast-moving lights and resonating computer music reflects the dissonance and transience of modern life.

Like technology itself, lightmusic can be a treat or a threat. When *Modulations* was performed at M.I.T.'s Hayden Gallery, a partially blind visitor discovered he could see the images, while a preschooler sat on the gallery floor whispering, "I'm afraid."—*Elizabeth F. Motzkin* □

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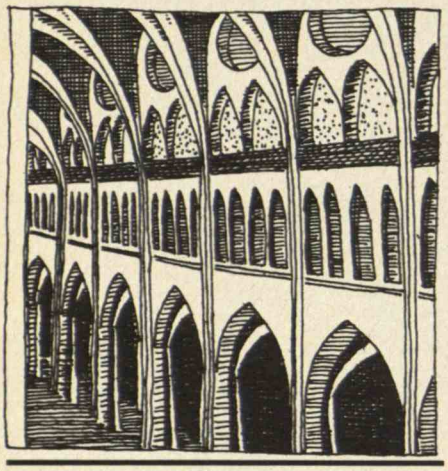
Technologies

Gothic Structures, Science Writing, and Chemical Dumps



Form Without Function

Experiments in Gothic Structure
By Robert Mark, M.I.T. Press, 1982

Reviewed by Jonathan Schlefer

Among the most extraordinary structures ever built are the medieval French cathedrals. The heavy vaults of the early Romanesque period strain upward from darkness; the skeletons of the high Gothic are suffused with light and echoes. In towering vaults, stone leans on stone around changing curves, until another vault or buttress takes up the thrust. These structural forces, radiating outward as the light radiates in, inspire a sense of mystery.

In *Experiments in Gothic Structure* Robert Mark examines the structure and art of medieval cathedrals. Most of the chapters are case studies of questions that have eluded others for centuries. Mark often grapples like some medieval theologian with arcane disputes. But he does obtain the answers, and sometimes they yield unexpected insights into Gothic building and architecture itself.

Consider the case of the pinnacles. These small spires stand above the outside edge of the massive exterior buttresses that absorb the vaults' thrust. To what end? The nineteenth-century Gothic-restoration architect Viollet-le-Duc insisted that the pinnacles were not merely decorative but helped maintain the buttresses' structural integrity. His twentieth-century critic, Pol Abraham, disagreed, arguing that since pinnacles are placed at the edge of each buttress instead of in the center, they make it less stable. Abraham's argument seems logical, but Mark wondered. He set out to see if the pinnacles might have something to do with resisting the often powerful winds that batter the steep wooden roofs above the cathedrals' stone vaults.

Since no structural-engineering calculations are sophisticated enough to decisively answer this and other questions, Mark resorted to photoelastic models that graphically portray the forces flowing through them. Engineers have used this technique to study machine parts but rarely buildings.

For each cathedral, Mark builds an epoxy model and hangs weights from it, scaled to represent the actual weight of the original stone. He heats the model until the epoxy becomes rubbery, and the load physically stretches some parts while compressing others. After cooling the model to lock in these deformations, Mark passes polarized light through it to create interference patterns—rainbowlike contours that map the stretching and compressing and hence the forces running through the model.

By pulling an epoxy cathedral model from the side to represent the wind force, Mark discovered a weak link in its structure. Though the vault's weight alone mostly produces compression, Mark found that a strong wind stretches the far leeward edge of the buttress. And masonry cracks under this tension. What could a Gothic builder do? He could pile a pinnacle on top of the part of the buttress that was being stretched. The pinnacle pushes on the critical place and prevents cracking.

How did the Gothic masterbuilders, ignorant of elementary arithmetic, place them with such uncanny precision? Mark offers a credible answer. Architectural design developed not only from one cathedral to the next, but within each cathedral. If the masterbuilder found some structural flaw in a cathedral under construction, he fixed it. If he found cracking in the upper outer edges of the buttress, he placed a pinnacle on top. This design-as-you-go method, which would horrify today's engineers, worked remarkably well but did produce one serious problem. At the Beauvais cathedral, tension cracks developed in a hidden part of the piers, Mark hypothesizes, and went unrepaired. The result: Beauvais collapsed.

Some of Mark's case studies have broad implications, while others, including the detective work on Beauvais' cracks, are mainly technical. But when he attempts with considerable fanfare to define the relationship between structure and aesthetics, he gets into trouble. He champions Viollet-le-Duc's "structural rationalism," which holds that "appropriate structural design . . . creates true style." In contrast, the opposing "antirational illusionists" are "appalled by the idea that great beauty could arise primarily from structural considerations"—they believe "fashion" plays a major role.

Mark doesn't say how widespread he thinks structural rationalism was, but the theory certainly says little about entire eras of architecture. For example, Renaissance buildings are generally supported by their walls. The pilasters, or columns attached to the facades, serve no structural purpose, whether on early churches in Italy or the grandiose palace at Versailles. Modern architects also have used structure as decoration. In the Seagram Building in New York, for example, Mies van der Rohe covered the true I-beams with fireproofing and attached decorative I-beams to the surface.

The daring Gothic cathedrals more nearly follow structural rationalism: decorative elements such as the pinnacles turn out to be necessities. But other elements that seem structural turn out to be superfluous—as Mark himself shows. For example, medieval vaults are joined in thickened ribs. Intuition might suggest that these help convey compressive forces to the piers. But the vaults could have joined in crisp sharp lines and the cathedrals would have stood up fine. How would they have looked? Horrible. The ribs are structurally superfluous but visually necessary.

Architects not only use apparent structure as decoration; they sometimes conceal true structure to trick people. Hagia Sophia, the great church of the Byzantine empire in Constantinople (now Istanbul), was just such a magic show. The central dome, 100 feet across and looming 150 feet overhead, was covered with ethereal glass mosaics, while sunlight streamed in through windows at its base. The dome "seems somehow to float in air on no firm basis, but to be poised aloft to the peril of those inside it," wrote the contemporary historian Procopius.

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Jonathan Schlefer is a senior editor at Technology Review *and holds a master's degree in architecture from the University of California at Berkeley.*

Science from the Inside Out

Science Observed: Essays Out of My Mind
By Jeremy Bernstein, Basic Books, 1982

Reviewed by Lynn Hall with Craig Decker

Jeremy Bernstein doesn't like most science writing. In his most recent collection of essays he describes what he sees as the sorry state of science communications:

"A spate of apparently very successful popular science magazines has appeared. If one actually takes the trouble to read them, one often finds them reflecting pop culture at its worst . . . The articles are superficial, frequently misleading, sometimes totally wrong, and ultimately disappointing . . . All this pop-culture hype will inevitably lead to disillusionment and boredom."

Bernstein's views on science writing are worth considering because he is not only an experienced and highly respected science writer but also a theoretical physicist. As a writer he is sympathetic to the difficulties of conveying science to the public; as a scientist he is in a position to judge the communication.

In an essay entitled "Can TV Really Teach Science?" he attacks TV's "science superstars," particularly Carl Sagan. He argues strenuously that scientist-communicators should not pretend to be all-knowing and should venture outside their own fields only with care.

Does Bernstein seriously mean that only experts are qualified to write about science? His own wide-ranging essays, in this book and elsewhere, suggest otherwise: Jeremy Bernstein writes about whatever subjects appeal to him, whether he is an expert or not. He excuses his own versatility by explaining: "I have tried to learn from the very best professionals whom I could find." Is he implying that other science writers are indiscriminate in their choice of sources?

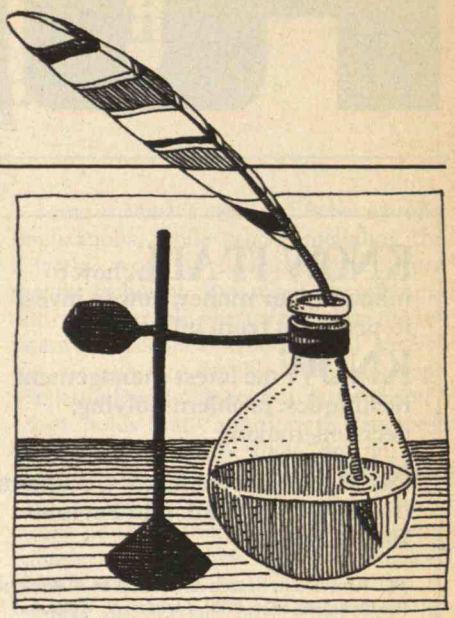
Bernstein continues: "As scientists trying to popularize our enterprise, we do have some advantages. . . . A firm background in one scientific area helps us to learn other disciplines with less difficulty." Scientific training is undoubtedly an asset in science writing, but taken to an extreme this attitude is disturbingly elitist.

Moreover, science writers on the "outside" are sometimes free to speak more openly than their tenure- and status-conscious colleagues within the scientific community. Bernstein himself has admitted that professional scientists who write for the public risk being branded as flakes. And, a writer with some distance from a field can provide much-needed perspective on the social and even scientific significance of research. With more researchers competing for fewer and fewer dollars, scientists are encouraged to inflate the importance of their own work.

Bernstein argues that most science writing gives no real sense of what *doing* science is all about. One reason is that most science writing is presented in an artificial "news" format that may be fine for politics but is woefully inappropriate and inadequate for science.

Unfortunately, Bernstein himself is not helping to correct these problems. His own essays give little idea of what the working life of any scientist, including his own, is like. Fully one-third of *Science Observed* is devoted to a profile of Martin Minsky, M.I.T. professor and pioneer in the field of artificial intelligence. Bernstein has been writing such profiles of prominent scientists for years. He uses them to convey a body of knowledge—in the case of Minsky, computers and artificial intelligence.

The portrait that ultimately emerges is of a set of ideas more than of a person. As interesting as the ideas are, one is left



wanting to know more about Minsky himself. (In contrast, nonscientist author Tracy Kidder paints a vivid picture of the people working to design a computer in *The Soul of a New Machine*.) This type of profile serves Bernstein's purpose, but it doesn't do much to improve public knowledge or understanding of scientists as people.

The portrait these essays paint of Bernstein himself is curiously flat. While we know what he thinks, we rarely know how he feels. For example, in "I Am This Whole World: Erwin Schrodinger," he begins: "There is a parlor game often played by my colleagues in physics. It consists of trying to decide whether the physicists of the extraordinary generation that produced the modern quantum theory in the late twenties were intrinsically more gifted than our present generation, or whether they simply had the good fortune to be at the height of their creative powers . . . at a time when there was a state of acute and total crisis in physics. . . . In brief, if our generation had been alive at that time, could we have invented the quantum theory?"

This is a fascinating question; it suggests that today's physicists are somewhat insecure about their talents. Unfortunately, Bernstein doesn't follow up on this tantalizing beginning. The next paragraph begins, "It is a question that will never be answered." This is almost beside the point; we are left wanting to know whether Bernstein himself ever feels such doubts.

Bernstein's essays and profiles are well-structured, logical, clearly written, and accurate. However, this style of writing, which works so well for straight scientific information, can be deceptive. Be-

cause he *is* a scientist (and his relentless name-dropping ensures that we never forget it), and because he presents his material in such a "scientific" manner, it's easy to make the mistake of thinking that he has covered his topic exhaustively, which isn't always true. His "just-the-facts" style suggests that he is totally objective, a near impossibility.

For example, in "Furth's Reactor and Fusion," Bernstein concludes a technical discussion of fusion research with arguments for why fusion power will be an essential energy source in the future. Rather insidiously, he goes from straight science to his own opinions, cloaking them in the language of a technical discussion. He settles the matter to his own satisfaction in the space of a few pages, but he ignores a number of related issues: political (the problem of weapons proliferation), social (the merits of centralized versus localized power generation), and technical (the appropriateness of nuclear-generated electricity as a means of space heating).

Perhaps the most interesting piece in the book is "The Need to Know," in which Bernstein describes witnessing two atomic bomb tests at Los Alamos during the 1950s. In this piece, at last, he lets the reader see into his heart: "As strange as this may now appear, the weapons represented a brooding and almost romantic presence. I, at least, lost sight of what they were and what they were for. They became symbols of the brotherhood of the need to know. Being part of the brotherhood gave me a somewhat superior feeling toward people—most people—who did not need to know. . . . I am trying to describe how things seemed to me—the solution of power."

Such candid and personal reflections can often be more revealing of scientists and science than bare descriptions of phenomena and ideas. At a time when science affects us all, we need a writer who can convey a feeling of what it means to be a scientist. Jeremy Bernstein explains facts well, but his writing would be both more interesting and more powerful if he would admit his own biases and bring us everything he has to offer. □

Lynn Hall is a doctoral candidate in geophysics at M.I.T. She was a National Science Foundation Science Writing fellow at Newsweek *magazine. Craig Decker is a graduate student in political science at M.I.T.*

Chemical Debacle

Love Canal: Science, Politics, and People
By Adeline Gordon Levine
Lexington Books, 1982

Reviewed by Ellen Williams

The Love Canal disaster is with us still and will be for a long time, if recent developments are any indication. The New York State attorney general announced a few months ago that levels of dioxin, one of the deadliest known chemicals, in evacuated Love Canal homes were "among the highest ever found in the human environment." Some findings indicated levels eight times higher than those measured in Seveso, Italy, after the tragic chemical-plant explosion there.

But following release of a study by the Environmental Protection Agency (EPA), the U.S. Public Health Service announced that the long-abandoned Love Canal neighborhood was habitable. Though this finding applied only to homes at least one and one-half blocks from the canal—beyond the area surveyed by the attorney general—some observers dispute the EPA's measurements.

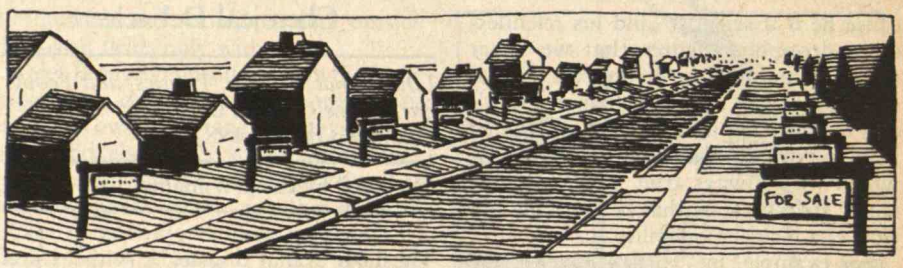
To complicate matters further, after a six-year delay the EPA recently issued final regulations for disposing of hazardous wastes in landfills such as Love Canal. The standards seem adequate for new landfills but are being criticized because regulations for existing landfills are weak.

The Love Canal crisis was triggered by the discovery that long-buried toxic wastes had contaminated homes in an area adjoining a chemical dump site. The canal was dug in the 1890s, then abandoned, and acquired in 1942 by the Hooker Electrochemical Co. as a dumping ground for chemical wastes from its large plant in Niagara Falls, N.Y. Hooker used the canal until it was full, in 1952, and then deeded the site to the Niagara Falls School Board for the token sum of $1. The deed contained a disclaimer acknowledging that the property had been filled with chemical wastes and absolving Hooker from any liability for personal injury or property damage resulting from the buried chemicals. The school board was warned by an attorney for the Hooker Co. that it would be inappropriate to use the land for any structures other than a school

or a recreation site. The school board built an elementary school on the dump, apparently never questioning why land unsuitable for other structures was suitable for a school.

After the school was finished, a suburb sprang up around it. In the mid-1970s, unusually heavy precipitation in the area increased residents' awareness of the deterioriation of homes, yards, and air quality, but the full story did not begin to be pieced together until 1976. Then a joint U.S./Canadian commission monitoring the Great Lakes detected the insecticide Mirex in Lake Ontario.

Love Canal: Science, Politics, and People carries us from that point through the purchase and evacuation of the contaminated homes by New York State and up to the summer of 1981. The book retells the residents' side—and only the residents' side—of the Love Canal story. Although much of the material will be familiar to followers of newspaper accounts, the chronology makes fascinating reading. Ms. Levine describes fully the impact of each revelation on the anxious and relatively uneducated residents. She reconstructs virtually the entire public record of the crisis, a record replete with bureaucratic runarounds and scientific non sequiturs. It is a record that, contrary to expectations of the residents, turns far less on science than on politics.



Levine, distressed at scientists' failure to recommend evacuating the residents, contends that "scientists who are called to participate in policy decisions have developed the rationale that they will confine themselves to assessing the probability of events happening and let *other* people decide what to do about it." Such reasoning is simplistic. As Levine herself points out, the scientists in this case had no authority to do anything; that was vested in the governor of New York.

Levine presents the Thomas panel, a group of distinguished scientists headed by Dr. Lewis Thomas of Memorial Sloan-Kettering Cancer Center and convened to pronounce the definitive verdict on health hazards of Love Canal, as a case study in scientific irresponsibility, or worse. The panel found that "there has been no demonstration of acute health effects linked to exposure to hazardous wastes at the Love Canal site . . . Chronic effects of hazardous-waste exposure at Love Canal have neither been established nor ruled out yet, in a scientifically rigorous manner."

Levine suggests that the panel's noncommital findings result from political pressure and conflicts of interest. (All the panel scientists were affiliated with institutions that received the bulk of their funding from the very department of health that commissioned the report.)

Her charges are serious, her points well-taken, and her reasoning persuasive, as far as it goes. But she damages her credibility by forsaking the scholarly tone that prevails throughout the remainder of *Love Canal*. The reader wonders whether her objections might stem simply from disagreement over what constitutes a "rigorous" demonstration of causality. The Thomas Panel may have used a stricter standard than Levine preferred.

Or, indeed, than anyone would prefer. A convincing case can be made that academic rigidity and prudent policy are incompatible. Unfortunately, Levine does not make that case. Instead, she suggests a sellout, and her presentation lacks sufficient objectivity to persuade me.

Levine's principal thesis is that the residents of Love Canal "were affected and behaved according to their perceptions and interpretations of the situation." In other words, people who believe they are victims act like victims—angry, fearful, and mistrustful.

But that is a universal truth. And of all the inexplicable behavior associated with the crisis at Love Canal, Levine has chosen to explicate the behavior of the residents, the behavior that is most plausible.

I would have preferred that Levine include more scientific history. At what points in the 30-year history of the canal did the hazards of certain chemicals such as PCBs and dioxin become known? What, specifically, were those hazards? When dumping first began, Hooker had complied with all public health requirements. These amounted to no more than demonstrating that the landfill would not attract flies and vermin.

Love Canal's chief weakness is its failure to illuminate the policymakers' side of the story. Although the author makes clear her intent to examine the social rather than the policy aspects of Love Canal, it is impossible to present a balanced account of the former to the complete exclusion of the latter. □

Ellen Williams, a free-lance writer, is former associate commissioner for policy coordination at the Food and Drug Administration.

WEATHER/ROBERT COWEN

(continued from page 6)

larger cloud systems. When the six-year experiment ended in 1976, it reportedly had shown that such selective seeding could enhance rainfall by up to 70 percent.

But there was a crucial caveat. No such potential could actually be claimed until confirmed by a follow-up experiment. The final report of this follow-up, called FACE-2, had not been released at this writing. However, it is well known that the project did not live up to its promise. To be valid as a corroborative experiment, all details of FACE-2 and the analysis of its results had to be specified in advance. This meant that the experimenters could not discount July 29, 1978 as a freak.

FACEing Facts

Under the FACE-2 rules, a seeding run took place once a day. The actual seeding material was chosen at random and was unknown to the experimenters; it might be silver iodide or merely inert sand. On July 29 the clouds came through with a massive rainfall. However, it turned out that the experimenters had seeded with sand. Whatever rainfall "enhancement" they thought they had stimulated was only a natural fluctuation. Without the "big day," they might well have duplicated the apparent success of FACE-1. With it, however, their average enhancement dropped to around 4 percent.

The FACE project helped drive home Dr. Braham's point that "experiments . . . that try to relate seeding to precipitation on the ground while ignoring the chain of intermediate processes are not likely to be very satisfactory." FACE researchers did strongly emphasize cloud physics but did not take many other factors into account. Chief experimenter William Woodley has been quoted in *Science* as acknowledging that "the whole process seems to be far more complex than we thought."

This does not mean that more than three decades of research on weather modification has produced nothing. Scientists have gained a greater understanding of cloud physics and related meteorology. There have been promising indications that some beneficial modification will yet be possible. Some Israeli experiments have appeared to enhance rainfall by 15 percent. But there has been no proof of success, no demonstration of a reliable technique.

As Dr. Braham has noted, when Vincent Schaefer cut a hole in a deck of clouds on November 13, 1946, "Meteorology was transformed from a predominantly observational-theoretical science to an experimental one." The transformation will continue. But for an indefinite time, at least for U.S. researchers, it's back to basics. □

PUBLIC WORKS/SAMUEL FLORMAN

(continued from page 11)

chemicals contaminate water supplies, offshore structures experience mysterious fatigue stresses, polymer gaskets in nuclear plants degrade when exposed to low-level radiation, and so forth. This is all very annoying, particularly to a society that is used to moving forward with its eyes on the stars.

But the situation has its positive aspects. If, into the foreseeable future, we will be patching pavements and replacing gaskets, then concerns about technological unemployment will prove overstated. Robots are not about to take over, and the age of the trowel and the wrench has not come to an end. In science and engineering a host of new challenges exist. Just as doctors are beginning to rethink their attitudes about geriatric medicine, so will scientists and engineers see new opportunities in solving problems of preservation and renewal. This is already happening, although one would never think so from reading the new science magazines.

Wisdom of the Ages

A good place to look for a different view is the monthly journal of the American Public Works Association. Here one can read about improving landfill techniques, rehabilitating maintenance equipment, renovating old wastewater treatment plants (including adding new computerized controls), and recycling concrete pavement (by fracturing it in place and applying a bituminous surface).

Evidence of the new reality is beginning to accumulate in many places. The Interior Department's Office of Surface Mining has announced a TV-guided method to backfill abandoned coal mines to stop Pennsylvania towns from sinking. Chemical companies are hard at work developing epoxies, paints, and other substances that will patch, clean, cover, and generally preserve existing installations.

This year the American Consulting Engineer Council awarded its grand prize for engineering excellence to a firm that purified groundwater contaminated by vinylidene chloride and phenol. The project entailed pumping the water from wells into aeration ponds, adding carbon adsorbers, and finally spraying the water into a marshy area. Other prizes were awarded to engineers for rehabilitating New York City's Manhattan Bridge, replacing a railroad bridge in Chicago, analyzing dams in earthquake areas, containing and cleaning up PCBs around a General Electric Plant in Oakland, Calif., building a new bus maintenance facility for Houston, and installing a vacuum wastewater collection system near Chesapeake Bay.

Even lowly potholes are coming in for their share of attention, as well they should, considering that approximately 200,000,000 of them had to be filled this year in the United States. The problem has been studied by the U.S. Army Corps of Engineers at the Cold Regions Research and Engineering Laboratory in Hanover, N.H. One finding is that holes simply filled and compacted by hand cost five times as much in the long run as holes that are trimmed, cleaned, dried, lined with a tacking material, filled, and finally compacted by machine. This is not exactly the sort of discovery for which Nobel Prizes are awarded, but it is a technique well worth knowing.

In facing up to the infrastructure crisis, we will have to temper our futuristic zeal with a solid sense of reality. This does not mean succumbing to contemporary despair, but rather acknowledging a certain wisdom of the ages.

These lessons remind me of a painting by Pieter Bruegel the elder that I saw several years ago in Vienna. Entitled *The Tower of Babel*, this famous work shows a mammoth circular building being constructed, its top just touching the clouds. The architectural detail is magnificent and sixteenth-century building techniques are exquisitely rendered. The tower has obviously been under construction for many years, probably generations. At the highest levels the new stone walls glow orange against the pale sky. The foundations, however, are dark and beginning to crumble. □

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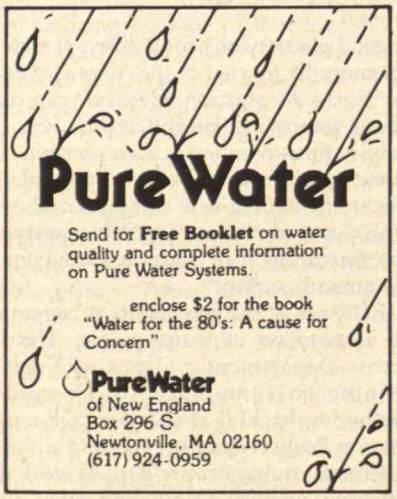

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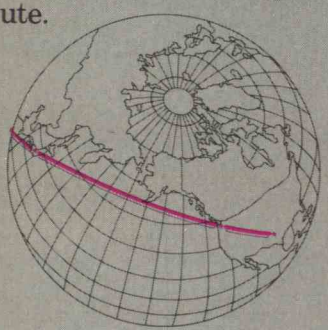

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